ONTARIO
ADVISORY COUNCIL
ON WOMEN'S ISSUES

CONSEIL CONSULTATIF
DE L'ONTARIO SUR LA
CONDITION FÉMININE

880 rue Bay Street, 5th floor/5ᵉ étage, Toronto, Ontario, M7A 1N3 (416) 326-1840 Fax/Télécopieur: (416) 326-1836 TDD/ATM: (416) 326-1835

GIRLS AND WOMEN IN MEDICINE, MATH, SCIENCE, ENGINEERING AND TECHNOLOGY

June 1991

Prepared by Rachelle Sender Beauchamp and Georgina Feldberg
for the Ontario Advisory Council on Women's Issues

Disponible en français

COUNCIL MANDATE

The Ontario Advisory Council on Women's Issues was established at arms-length from the government in 1973, and is in a unique position to effectively question the government's direction and policies. Council's mandate is to advise the Ontario government on all matters pertaining to the achievement of economic, social and legal equality for women and: to respond to requests from the Minister for advice and consultation; to hold public meetings for the purpose of stimulating public discussion and accessing the opinions of women; to identify specific areas requiring the attention of government and to recommend legislation and programs changes to the Minister Responsible for Women's Issues.

There are 15 members, all of whom are appointed by Cabinet on a part-time basis. Meetings are held in Toronto and work on identified issues is done through committees. Council brings a balance of women's views from across the province to the government's attention.

92-02820/

COUNCIL MEMBERS

Susan McDonald, Vice-President, Arva

Marielle Cousineau, Kapuskasing

Margot Dallaire, Sudbury

Bernice Dubec, Thunder Bay

Mila Eustaquio, Mississauga

Dianne Harkin, Winchester

Catherine McPherson, Toronto

Sarah Melvin, Sioux Lookout

Lana Mitchell, North Bay

Helen Penfold, Owen Sound

Carrol Anne Sceviour, Toronto

Lucya Spencer, Ottawa

Lynn Zimmer, Peterborough

STAFF

Elayne Ceifets, Acting Executive Officer

Lydia Oleksyn, Communications Officer

Melody CarvalhoMount, Administrative Assistant

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

INTRODUCTION 1

I. ELEMENTARY AND SECONDARY EDUCATION OF GIRLS IN MATH, SCIENCE AND TECHNOLOGY 8

A) Teacher Behaviour 11
  Differential Treatment 12
  Evaluative Feedback 12
  Sex-role Stereotyping 13
  Overhelping 13
  Teacher Attitudes Towards Math and Science 14

B) Other Barriers 14
  Textbooks and Instructional Materials 14
  Curriculum and Curriculum Requirements 15
  Career Guidance and Counselling 16
  Extracurricular Activities 17
  The Media 17
  Parents 17
  Peer Groups 18

C) Interventions 18
  Career and Role-modelling Programs 19

D) Curricular Initiatives 20
  Single-sex Programs 20
  Curriculum Reform 21
  Teacher Training and Staff Development 22

E) Extracurricular Activities 23
  School-based Programs 23
  Non School-based Programs 24
  Science Centres 25

F) Conclusion 25

II. POST SECONDARY EDUCATION 27

A) Background: The Purposes of Post-Secondary Education 27

B) Community Colleges 29

C) Institutes of Technology, Trades and Vocational Programs 30

D) Universities: Undergraduate Education 32
Full-time Undergraduate Enrollments 32
Part-time Undergraduate Enrollments 33

E) Universities: Graduate Enrollments 34
Full-time Graduates 34
Part-time Graduates 36

F) Explanations for Patterns of Women's Enrollments in Post-Secondary Programs in MMSET 37
Primary and Secondary Education 37
Pedagogy and Psychology 37
Social Stereotypes 39
Curriculum and Content 40
Feminism and Anti-Feminism 41
The Pipeline 42
Francophone, Minority and Disabled Women 46
Race and Ethnicity 46

G) Conclusion: Directions For Change 47

III. WOMEN IN THE SCIENCE, MATH AND TECHNOLOGY WORKPLACE . . . 50

A) Background: Women and Work 52
The Problem of Numbers 52
Pay Inequity, Job Segregation and Stratification 55

B) Women in MMSET and the Problems of Non-traditional Work 58
Tokenism 58
Training 58
Career Interruption and Perceptions of Scientific Genius 59

C) Interventions 60
Apprenticeships 60
Mentoring 60
Re-entry and Career Change Programs 61

D) Recruitment vs. Retention 61
  The Scientific "Double Day, Double Blind" 63
  The Prestige of Science and Women's Career 63
  Status: Invisible Women: Traditional Careers in Science and Technology 64

E) Doubly Disadvantaged 65
  Francophone Women 67
  Native Women 67
  Visible Minority Women 67
  Disabled Women 68

F) Bringing all Women Back into the Technologic Trades 69

G) De-skilling Technological Obsolescence 70

H) Conclusion: The Percreption that Women Will Change Science 70

APPENDIX 73

BIBLIOGRAPHY 74

EDUCATIONAL RESOURCES 89

EXECUTIVE SUMMARY

Why do we want more young women to study medicine, math, science, engineering and technology (MMSET)? Women in Ontario are receiving contradictory messages and there appears to be a great disparity between the rhetoric and the reality. On the one hand, women are encouraged to pursue MMSET careers because they are well-paid and rewarding and because Canada will face a severe skills shortage if they don't. On the other hand, the reality is that the atmosphere, the structure and the direction of MMSET classes and careers are often inamicable to women. (For example, it is frequently very difficult to combine MMSET jobs with raising a family because of the time and travel commitments). Also, the lack of funding for research and development in Canada (a level which is already below that recommended for Third World countries and which continues to decline) means that career opportunities in many MMSET fields are limited.

In this report, we summarize recent trends in women's participation in MMSET in Ontario, both in the classroom and on the job. We then review the many factors responsible for the continued low participation of women. We also provide an overview of programs in Ontario and elsewhere which seek to improve the recruitment and retention of women in MMSET.

Just as there are no simple - or single - causes for the low participation of women in many MMSET fields, there are no simple answers. It is not enough to change the attitudes of women and the stereotypes about women. It is also necessary to make a serious and sustained attempt to transform the teaching and practice of science and technology itself. We must also better understand the ways in which science and technology shape our society and are shaped by it.

History

Women have long participated in the development of Canadian mathematics, medicine, science and technology, but the roles they have played have been uneven and increases in number have been slow and unsteady. Ontario colleges and universities began to award medical and scientific degrees to women during the late-nineteenth century. Thereafter, large numbers of women worked as technicians. During the Second World War, many women entered the scientific and technical workforce, only to leave after the war ended. The percentages of women who entered MMSET actually declined during the 1950s and 1960s, but the wave of feminism that swept Britain and North America during the 1970s renewed efforts to increase women's participation in MMSET. Still, despite some gains, women continued to remain clustered in occupational ghettoes. Women dominated fields like nursing, social work and household science but remained a distinct minority in the biological and social sciences, in engineering and the applied sciences, and in mathematics and the physical sciences. This ghettoization characterized patterns of both education and employment.

These patterns of women's education appeared to change, during the early 1980s, when more women entered the sciences. These gains need to be interpreted cautiously, however. First, the increase in women's scientific enrolments is part of a larger phenomenon of women's increased participation in higher education. By 1987, women represented 53% of full-time community college students and 50% of full-time undergraduates enrolled in Ontario universities (See Figure 9, page 29). Secondly, the increases were not sustained. While the numbers of women enrolled in arts courses increased throughout the 1980s, the number who enrolled in the sciences actually began to decrease. By 1987, the percentage of full-time, women science students in Ontario had fallen from 40% (in 1980) to 30%. (See Figure 11, page 31).

Education

The forces that steer girls away from science, math and technology begin early and continue throughout secondary school. In 1990, after almost 20 years of intervention programs, young women in Ontario still enrol in OAC (formerly grade 13) math, physics and computer science courses only half as often as boys. The disparity in technology courses is even greater. Furthermore, many of the recent gains made in the percentage of female students in these courses is due less to increased female enrolment than to decreased male enrolment. The low enrolment of young women in math and physics courses is of particular concern because without them, young women are unable to pursue engineering, science or technology at the post-secondary level.

Cross-cultural studies indicate that women do not universally steer away from the sciences. Cultural and psycho-social factors, rather than innate biological characteristics, keep Canadian girls and women out of MMSET. These include the attitudes of teachers and parents toward math and science; peer pressure; curricula and teaching practices that "turn off" both male and female students in math and science classes; and teachers' behaviours which reinforce stereotyped assumptions about appropriate sex roles and create a chilly classroom climate for young women. In most classrooms, it is too often male students who manipulate the scientific apparatus or get most computer time and the females who watch or take notes. Young men receive more of the teacher's attention and are rewarded for taking risks. Young women are praised for being "nice". Messages from others influential in the lives of young women - parents, peers and television - reinforce what takes place in the classroom.

One striking example of the impact of cultural and social factors is the fact that more Francophone than Anglophone young women in Ontario enrol in optional high school math, science and technology courses. (This is true in other provinces as well). Also, young women from visible minority groups or families with low income are "doubly disadvantaged", since they are less likely than their white, middle class classmates to take math and science courses or to pursue non-traditional carers.

Patterns of primary and secondary education that produce inadequately prepared students are key determinants of women's low participation in MMSET in Ontario, but additional factors prevent even those young women who want to pursue a scientific education or career from realizing their goals. Often, it is the "best" and the "brightest" female science graduates who opt for jobs in other areas. At the Ph.D. level, attrition is a particularly significant problem. Women Ph.D. students, like other minorities, lack the mentors, networks and support systems needed to sustain them through what is often a long and lonely process. Despite their achievements and dedication to work, female graduate students in the sciences often have low self-esteem. Their estimation of self worth derives, in part, from the few tangible rewards given to women science students. Women fare poorly on standard measures of success, namely the acquisition of prestigious jobs, fellowships and awards.

The Workforce

Over the past 15 years, women have made some gains in all areas of MMSET. They have increased their numbers in fields previously open to women and they have infiltrated areas - such as dentistry and veterinary medicine - in which no women previously worked. However in both post-secondary education and the workforce, women's gains are not uniform. The "problem" of women's employment in MMSET is, to some extent, a relative problem. It is partly because women have entered other areas of the workforce in greater numbers that their representation in MMSET appears low. In addition, women's contributions to the MMSET workplace are often overlooked and undervalued. Women have always worked in MMSET, as technologists, technicians and laboratory assistants, but this work is not lucrative, nor is it high-profile and high-status.

Two problems co-exist. First, women's work is ghettoized. Women are not evenly represented throughout the technical trades. They tend to cluster in the lower-status, less lucrative positions traditionally identified as "women's jobs". Some areas, such as electronics remain almost exclusively male. Though women now represent a majority of graduates in the biomedical sciences and technologies, and though they are steadily increasing their participation in the workforce, the representation of women in mathematics, engineering and the physical and applied sciences remains appallingly low. Even here, women are much better represented in some disciplines (e.g. civil or chemical engineering) than in others (e.g. mechanical engineering).

Second, women are rarely represented in the upper ranks of any field. For example, though women represent a majority of workers in the health care sector, they are disproportionately concentrated in the lower-status, less well-paying jobs. They work as nurses, technologists, technicians and aides. The professions and university faculty are similarly stratified, with women under-represented at the higher professorial ranks or in management.

Women who work in MMSET share many problems with other women in the paid labour force. Like other working women they have difficulty finding childcare and balancing home and career. They move through the ranks more slowly, are paid less, trained less and harassed more. In virtually every MMSET field, women's salaries tend to be 10% lower than men's.

Women in MMSET also face several barriers other women do not. First, **tokenism is burdensome**. Where women are a small minority, they experience added stress due to their high visibility, social isolation and the need to constantly "prove" themselves. Secondly, it is more **difficult to find mentors,** since there are few senior women and men are more likely to mentor other men. Third, many MMSET careers are so demanding in terms of time and travel commitments that, particularly early on in a career, it is very **difficult to combine career and family**. Unfortunately, this period of peak job commitment usually coincides with a woman's prime child-bearing years. Finally, those women that do take time off may find **re-entry difficult** due to the rapid pace of knowledge growth and technological change in MMSET fields.

Given these barriers, it is not surprising that the rates of attrition for women in many MMSET fields (e.g. engineering, science, nursing) are high.

Intervention Programs

The low representation of women at all levels of MMSET has not gone unnoticed. In the past two decades, many attempts to remedy this situation have been instituted, particularly at the intermediate and senior (grades 7-12) and post secondary levels. Programs detailed in this report include role-modelling programs which expose students to women in non-traditional MMSET careers; all-female science, math or technology classes; teacher training with respect to classroom equity; special computer or math clubs for girls; the production of non-sexist textbooks and other curriculum materials; special scholarships for women in MMSET fields; mentoring programs; and college based bridging programs for re-entry women in the trades.

In terms of the workforce, most employers have focused on the recruitment of female MMSET graduates. Less attention has been paid to the retention of female MMSET employees and to providing career change opportunities ("bridging programs") to women employed in clerical or other traditional fields.

At the elementary and secondary level, most intervention programs are isolated, short term efforts run on a shoestring. A comprehensive, sustained and integrated approach to gender equity issues with better coordination, funding and follow-up are all needed.

There is also a need for more accountability: benchmarks and targets must be established at the provincial and local levels and performances monitored and made public. This process will not work unless parents are made full partners in their daughters' education.

Improvements could also be made in teacher education and in the awareness of curriculum equity issues among principals, superintendents and trustees. Outstanding initiatives by individual teachers or schools should be recognized and rewarded. Curriculum equity is closely tied to employment equity and it is important to have more female math, science and technology teachers at the high school level. Extracurricular activities in math, science and technology, particularly for disadvantaged girls, are needed. Finally, experience in other countries suggests that the additional mandatory math and science courses will increase the numbers of females in MMSET careers.

At the post-secondary level, monetary incentives, mentorship, internship and networking programs to recruit more women into science are required. These efforts can be effective only if they are coupled with measures that will retain women. Such measures include a fundamental reform of the teaching and practice of science. If we persist in claiming that science and technology are wholly objective and neutral, if we continue to ignore and denigrate attempts to create a more humanistic, a greener, and a less hierarchal science, then we will lose not only another generation of young women, but also an increasing number of young men.

Ultimately, women's participation in MMSET is tied to the labour market. Hence, measures designed to increase women's participation in MMSET must include practices which will ensure them work.

At all levels, there is a need to rethink the role of women in MMSET. It is important to focus less on the shortcomings of women and more on the shortcomings in the teaching and practice of MMSET. And to balance the calls for increased participation of women in MMSET with calls for reform in ways that do not create additional burdens for women.

Conclusion

In general, we favour action over research. Statistics are available and action is overdue. But we also call for a theoretical reorientation to guide new research. Too often, studies of female participation in MMSET have begun with the premise that girls and women are the problem. We propose a shift away from this model. We suggest that women's participation in MMSET be conceptualized as part of the broader problems with science, women and work. Furthermore, we advocate an approach that recognizes the importance of transforming scientific practice and pedagogy, but does not assign women sole responsibility for this task.

INTRODUCTION

The Canadian woman scientist, physician or engineer, once thought strange and rare, is becoming more common; or is she? Over the past two decades, Canadians have continually promoted women's participation in medicine, mathematics, science, engineering and technology (MMSET) with interventions that have taken two, distinct but interrelated forms. Academics and activists by the droves have sought to understand, and publicize the barriers that impede women's entry into, and continued success in, MMSET. Educators and employers have then taken the academic findings and, spurred on by social, political and legal changes, have sought to redress gender imbalances. In schools and in the workplace, they have implemented programs designed to attract women and promote their careers in the sciences. These interventions have had some success. As we shall show, the numbers of women entering medicine, engineering, the sciences and the technologic trades have increased over the past decade. Yet, despite extensive activity, both quantitative and qualitative evaluations continue to indicate that women still do not participate fully in MMSET. The various groups that represent women's interests remain concerned.

This report is both a product and analysis of that concern. We begin with a survey of recent changes that have occurred in Ontario. Through a broad, historical overview, we evaluate patterns of women's education and employment in MMSET since the second world war. We focus, however, on the changes that have occurred since 1975. The year 1975 marks our starting point because it is the year in which the Ontario Ministry of Colleges and Universities published two parallel reports on the status of women in Ontario's universities and twenty-two community colleges - Colleges of Applied Arts and Technologies. (McIntyre, 1975; Lewis, 1975). Drawing statistics from published sources, we offer a summary of women's achievements. We also offer brief interpretations of the trends. The literature on women and MMSET, as our bibliography indicates, is voluminous. We have surveyed that literature to identify recent innovations, in both education and employment practices, made to encourage women into MMSET. We offer analyses of these interventions, and we use them to assess the reasons that underlie Ontario's continued concern about women's participation in MMSET. Neither the scope of the study nor the resources available allowed for extensive primary investigation.

Development of Canadian Awareness re Women's Participation in MMSET

Women have long participated in the development of Canadian mathematics, medicine, science and technology. "Despite the Odds"[1] some nineteenth-century Canadian women did contribute to the sciences in conventional ways. Since at least the middle of the nineteenth century, they acquired formal education. In Upper and Lower Canada, women practiced medicine, and by the mid-1880's, medical colleges for women existed in both Toronto and Kingston (de la Cour and Sheinin, 1986). By the 1890s, Ontario's colleges and universities had awarded women degrees in psychology, physics and chemistry. (Ford,1985; Chu and Macdonald, 1990). Women also made less formal contributions to botany, natural history, the healing arts, and other technologic disciplines (Ainley, 1990; Biggs, 1983). Moreover, many of these women published their findings in scholarly articles. A recent study of scientific publications notes that, as early as the 1870s, Canadian women regularly published articles on general science, entomology, technology, animal husbandry, agriculture, and architecture. A majority of these women came from Ontario (Chu and Macdonald, 1990).

---

[1] The phrase is borrowed from Marianne Gosztonyi Ainley, ed. *Despite the Odds: Essays on Canadian Women and Science*, (Montreal: Vehicule Press, 1990)

An historical record, which emphasized male achievements, and ascribed greater importance to fields in which men predominated, denied this tradition of women's scientific work. Until the 1970s, standard histories of science and medicine focused on elite fields and elite achievements. Viewing the scientific professions as a male domain, these histories virtually ignored the women who did infiltrate the scientific ranks (Ainley 1990, Walsh, 1978 Rossiter, 1982). The tendency to focus on great discoveries of great men led historians to both undervalue women's achievements in traditional scientific areas and to overlook those domains - such as nursing, midwifery, and the technical trades - in which women abounded. Significant numbers of North American women worked, during the late-nineteenth and early-twentieth centuries, as technicians and assistants in astronomy, genetics, and agriculture, Before 1980, few histories of these professions existed (Rossiter, 1982).

However, historiography cannot be held solely responsible for the low level of women's participation in MMSET. The scholarly tradition which wrote women out of the historical record reflects broader Anglo-American cultural traditions which presumed that women did not work, especially not in the medical, scientific and technical realms. To justify this order of things, scientists and social scientists have invoked numerous and varied explanations. These include:

- "nature" or the anatomical, physiological, and evolutionary forces that shape woman's special being;
- "nurture" or the social forces which encourage women to believe that their proper place was in the home;
- the "pipeline," or the economic and political forces that limit opportunities for education, awards and work experience; and
- the psychological factors that contribute to women's self esteem and learning styles.

Nature, a host of medical, psychological and scientific professionals have argued, rendered women unfit for the scientific professions. The belief that males and females have different, natural, mental abilities has existed for centuries, but it became increasingly popular in nineteenth-century North America. In 1871, Charles Darwin offered a scientific basis for the origins of these differences. In his *Descent of Man* (1871), Darwin proposed that the forces of evolution and natural selection had ensured that women were more emotional and intuitive, while men were more analytic and rational. Thereafter, North Americans often invoked a special female biological nature to justify their opposition to the education or employment of women. Their grounds included the following arguments:

- that women had been born with smaller brains which could neither absorb nor process large quantities of information;
- that menstruation and the demands of pregnancy caused women's bodies to operate at a slower metabolic rate; and
- that the special needs of reproduction drew energy away from women's brains.

Should women choose to defy nature by expending too much energy in study or work, professional and popular advice manuals warned, they would deplete the reserves needed for childbearing; they would both destroy their own health and produce inferior children (Clarke, 1873; Englemann, 1900; Rosenberg and Smith-Rosenberg, 1973).

These nineteenth century beliefs about biologically predetermined male and female abilities have persisted into the twentieth century. During the first decades of this century psychologists regularly expounded on the different mental abilities of the sexes. "The predominating faculty of man is reason", article after article maintained. "Of woman it is intuition". Canadians regularly popularized and publicized these presumed "differences" in menfal ability. "Women do not make good scientists", one Canadian newspaper boldly proclaimed. "They are much better laboratory technicians, but they do not have the male's larger grasp of scientific problems". A recent study of university-life also indicates that Canadians employed these preconceptions about differences in male and female abilities to justify the exclusion of women from fields that required analytic skill (Axelrod, 1990).

Many scientists have systematically disclosed the flaws in nineteenth and twentieth century theories about innate or biological differences in the mental abilities of the sexes (Fausto-Sterling, 1985; Hubbard et. al; 1982; Bleir, 1984). Despite their efforts, however, the belief that nature endows the sexes with different mental abilities persists today. Over the past decade, biological determinism - the belief that differences in ability found among the races and between the sexes can be traced to genetic, hormonal or other biological factors - has even enjoyed a resurgence. Both the scientific and popular presses have once again set forth the view that women are "biologically" incapable of doing science (Benbow and Stanley, 1980, 1982; Mohr, 1990).

Sociologists, historians and psychologists regularly counter arguments about woman's special nature with the assertion that "nurture", or social forces, direct women away from science. A strong cultural tradition that locates women's work in the home has created additional barriers for those Canadian women who tried to break into the scientific professions. Historically, the social stereotype of woman as homemaker ensured that few university places were opened to women. Still fewer scientific places existed. Despite the founding of medical colleges for women, during the late 1880s, Canadian women did not have easy access to medical training. Between 1883 and 1964, only 1550 women graduated in medicine in Canada (MacDonald and Webb, 1966). Still fewer women graduated in mathematics and the "hard" and "applied sciences". During the period 1931 to 1944 alone, Canadian colleges and universities only awarded 13 undergraduate degrees in applied science to women. (*Canada Yearbook*, 1946).

Social stereotypes of women's roles generated not only barriers of exclusion to university but also barriers of attrition. The image of woman as homemaker created by society and adopted by female students ensured that significant numbers of women entering university during the first half of this century, did so with the intention of preparing for motherhood. Schools and universities rose to this challenge and adopted the educational goal of preparing good wives and mothers (Strong-Boag, 1988; Axelrod, 1990). Teachers, deans and other academic officials discouraged female students from pursuing scientific studies. They presumed that these women would go on to be wives and mothers and hence would not pursue careers. Thus they believed that women who were allowed to study science would waste scarce educational resources.

Those women who persisted often experienced the problems of what has recently been labelled the **"pipeline"**. During the 1920s and 1930s, most girls who expressed an interest in MMSET found themselves channelled or tracked into biology or bacteriology. Financial difficulties and social stereotypes made it difficult for them to complete their studies. Successful graduates found themselves pushed, again toward the "female" work ghettoes of laboratory work and nursing. Those who bucked the trend, and qualified as physicians, engineers, or scientists, often found that they were ineligible for prestigious internships and post-doctoral fellowships. Limited opportunities for employment compelled many members of the earliest generations of Canadian women physicians and scientists to leave for practice abroad. The women who stayed often complained that more was expected of them. "When a woman doctor makes a mistake", a commentator on women's medical education lamented, in the *University of Toronto Undergraduate Medical Journal*, (1936) "she is often criticized doubly; once for her mistake and once for being a woman". If Canadian society has limited expectations for women physicians and scientists, it has traditionally held them to higher standards.

Though standards for women's scientific work were higher, the pay women received was lower. Canadian women who did manage to make a career in science or medicine, in the years between the two world wars, generally earned much less than their male counterparts. Inequity existed at all levels and in all professions. For example, the average salary for a woman physician was just over half that paid to a male; women lab technicians earned a pittance. The Depression exaggerated these gender specific wage differentials. During the 1930s, for example, the wages of male physicians decreased by 10%; for females, they decreased by 40% (Axelrod, 1990).

Patterns of unequal access to education, differential treatment in schools and on the job, and lower pay have directly discouraged women's participation in MMSET (Sheinin, 1982, 1983). They have also had indirect influence through what psychologists have labelled **self-esteem**. Women doctors were often condemned for lacking confidence, an editorial in the *University of Toronto Undergraduate Medical Journal* noted, in 1936. This was little wonder, the author suggested, for "Complete and justifiable self confidence can come only with experience, responsibility, and a sense of achievement". Girls in math/science classrooms, undergraduate MMSET students, and women in the MMSET workplace, study after study has shown, have regularly been denied these opportunities.

Changing Patterns of Women's Employment in MMSET

The labour shortage created by the second world war created some new opportunities for women in MMSET. The forces of employment in turn generated new educational opportunities. Canadian women began to enter scientific fields in greater numbers during the 1940s. Still, though women managed to make inroads into many professions, male bastions, like Forestry and Veterinary Science, remained. (See Figure 1).

Number of Canadian Women who Received Undergraduate Degrees in MMSET over total degrees awarded

	1931	1943
B.Sc	45/252	76/362
Medicine	26/535	31/608
Pharmacy	10/208	18/115
Agricultural Science	2/160	9/211
Engineering	0	2/775
Architecture	0	3/17
Forestry	0	0
Veterinary Science	0	0
Dentistry	0	2/133

Figure 1 Statistics Canada; *Canada Yearbook*

The percentages of women entering MMSET declined again during the 1950s and 1960s, but the wave of feminism that swept Britain and North America, during the 1970s, combined with economic forces to issue a new challenge to women's traditional roles.

As scholars like Walsh, Rossiter and Sheinin (1982, 1983, 1984) worked to right the historical record, governments, universities and industries acted to increase the participation of women in scientific professions. By the mid 1970s, the percentage of Canadian women who received degrees in scientific and technical fields had increased substantially. To measure the extent of these changes in 1973, the Ontario Ministry of Colleges and Universities commissioned two studies: one on Women and Ontario Universities and one on Women and the Colleges of Applied Arts and Technologies. The former, written by Gale McIntyre, opened with the grim observation that:

> " Two out of five undergraduate students are women. One in four graduate students is a woman. For every discipline dominated by women, three are dominated by men. In short, fewer women than men are entering university, fewer still are continuing on to graduate school and at both levels women are found in a limited number of what might be considered 'traditional fields'. The most recent information available suggests that the percentage of women studying at all levels is on the rise, and in some disciplines, significantly. But, in general terms, the enrolmént profile parallels the overall pattern of women's participation in the work force. 'Women are dramatically entering the world of paid work' says one report. This change, however, has been quantitative only. Women are still crowded into the few low-paying occupations they have traditionally held" (Ontario Ministry of Colleges and Universities, 1975).

McIntyre's report highlighted two distinct problems. First, despite some gains, women remained underrepresented in MMSET. Second, women continued to dominate fields like nursing, social work and household science while they remained a distinct minority in the biological and social sciences, engineering and applied sciences, mathematics and physical sciences. These female ghettos existed both among students and faculty. Women professors, few in number, seemed concentrated in a small cluster of disciplines - primarily education, the fine arts, library science, and household science.

Similar patterns of **ghettoization**, or occupational segregation, prevailed outside of academe. During the 1970s, women came to represent an increasingly large percentage of the labour force, but outside the educational system as within, they were not evenly distributed throughout the trades and professions. Women remained segregated in narrow, traditionally defined "women's" jobs, such as nursing and clerical work (*Report of the Royal Commission on Status of Women*, 1970).

The historical barriers of nature, nurture and pipeline identified above, continue to act in the 1980s (Sheinin, 1981, 1982, 1983, 1984). In addition, a new set of forces have also shaped women's patterns of entry into MMSET. These include general changes in the legal, economic and social status of women; feminism; and the new critiques of science. The "problem" of women's under representation in MMSET is, to some extent, a relative problem. Over the past two decades, legal, economic and social reforms have helped women to participate more fully in public life. It is partly because they have entered other areas of training and work in greater numbers that their presence in MMSET seems low.

The relation of Canadian women physicians and scientists to the more general women's movement has also affected patterns of women's representation in MMSET. Professional women scientists and physicians have, to a great extent, remained apart from academic or mainstream feminism. In turn, women's studies and women's movements have not always identified and supported the needs of women in MMSET. The seemingly divergent priorities of these two groups have generated debates about feminized, female, and feminist science (Bentson, 1982; Bleir, 1988; Keller, 1982). Liberal feminists have sought, essentially, to "feminize" MMSET by acknowledging women's contributions and increasing the number of women involved. Radical, separatist, and socialist feminists have additionally launched a critique of scientific practice. Invoking both "nature" and "nurture", some such critics have argued that women tend to undertake more contextual, integrated research projects (Franklin, 1990; Gilligan, 1982; Keller, 1983; Belenky, 1986). This suggestion has led, at one extreme, to the labelling of science as "male stream" and alien to "natural" female patterns of cognition; it has led, at the other extreme, to appeals for a more contextual, "better", "female" science. In between, the recognition that women have sometimes pursued non-traditional scientific career patterns, and engaged in low-status, non-traditional scientific research has led scholars to make the appeal for a more integrated, diversified and "feminist" science. These debates have shaped patterns of women's participation in MMSET, and they also provide a perspective on patterns of difference and exclusion that must be considered.

So must the impact of the recent anti-nuclear movement, environmentalism, holistic health movement and health promotion. These movements have generated critiques of the theories and practices of traditional science, precipitated calls for new, "greener", more "humanistic" and "less hierarchical" practices, and attracted large numbers of women (Franklin, 1990; Savan, 1990). The ways in which the attempts to build a new science provide gateways for women's entry into MMSET must be considered, as must be the additional burdens that the calls for a new science place on women who choose careers in MMSET.

The remainder of this report evaluates changes in the patterns of women's education and employment in MMSET that have occurred since 1973. Our analysis focuses on the ways in which "nature", "nurture", "the pipeline", and "psychological factors" have shaped recent trends in Ontario women's participation in MMSET. It explores as well the impact of more recent social and political movements - such as the women's movement.

The analysis is divided into, first, a discussion of elementary and secondary education, second, a discussion of post-secondary education, and third, a discussion of the workplace. Our analysis attempts to evaluate the impact of these changes from the perspective of women students, women educators, and practicing women scientists, physicians, engineers and technologists. No complete assessment or explanation of the changes that have occurred can be provided without some analysis of regional, socio-economic, linguistic and ethnic/racial variations. We have attempted to be sensitive to these variables but the available data do not always allow for such an assessment.

I. ELEMENTARY AND SECONDARY EDUCATION OF GIRLS IN MATH, SCIENCE AND TECHNOLOGY

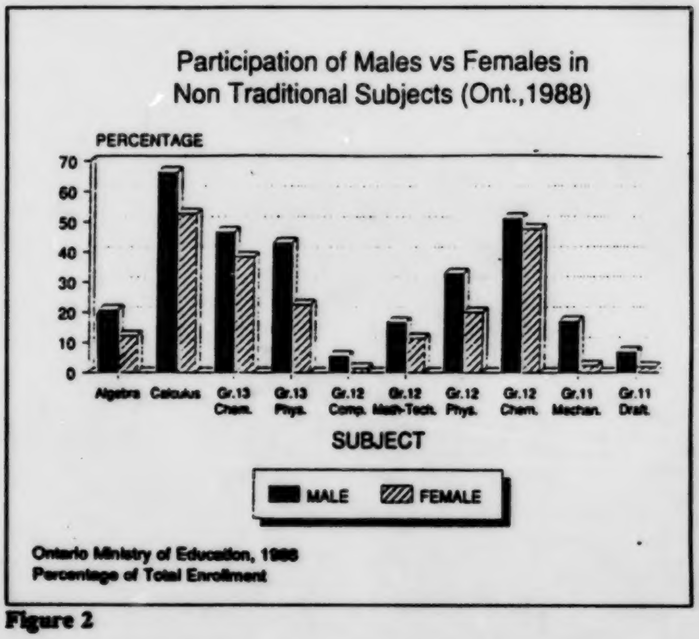
> "What other group (than girls) starts out ahead—in reading, in writing, and even in math—and twelve years later finds itself behind?"
>
> (Sadker and Sadker, 1982)

> "The separation of girls from science starts early in life...and the gap becomes progressively more obvious at each succeeding stage of the education process."
>
> (Science Council of Canada, 1981)

> "...I was certainly not given the belief that I could give something to science and that it could give something back to me."
>
> (Stephanie, a high school student quoted in Tobias, 1990)

The forces that steer girls away from science, math and technology begin early in life and continue throughout elementary and secondary school. Serious attempts to study and solve this problem began in the early seventies and it would be nice to report that the solution is at hand. Unfortunately, that is not the case. Today, in 1990, after almost 20 years of research and attempts at intervention, girls in Ontario continue to opt out of science, math and technology courses at a rate which exceeds that of their male classmates.

Statistics compiled by Joan Scott (1982), and, more recently by Sharon Haggerty (1989), document this continuing problem. In Ontario, in 1988 the participation rate of female grade 13 students in physics (a prerequisite for many University science programs) was 22%, as compared to 43% for males (participation rate refers to the percentage of all students enrolling in a particular course). Overall, twice as many boys as girls enrolled in grade 13 physics. In other courses, such as computer science and technology, discrepancies are much larger: for example, almost four times more male than female students in computer science and architectural drafting (see Figure 2).


Participation of Males vs Females in Non Traditional Subjects (Ont.,1988)

Ontario Ministry of Education, 1988
Percentage of Total Enrollment

Figure 2

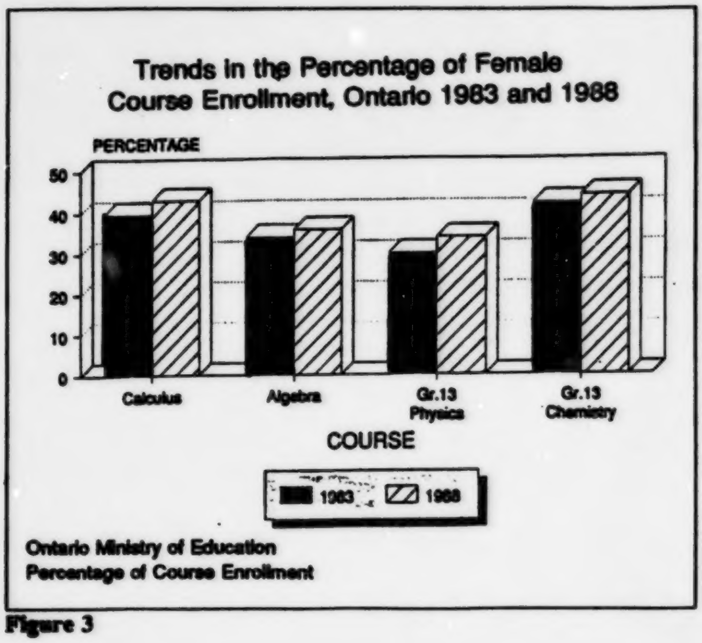


Figure 3

There have been some encouraging trends in the past five years. In Ontario, the percentage of female students enrolling in grade 13 mathematics and science courses (that is, the percentage of total course enrolment which is female) has been inching upward (see Figure 3). For example, in 1983 grade 13 (now OAC) physics enrollment was 30% female and this increased to 34% in 1988. However, there is disturbing evidence that we may be winning the battle but losing the war: participation rates for young women actually declined slightly in that period (Figure 4). In 1983, 25% of all female grade 13 students enrolled in physics; the corresponding figure for 1988 is 23%. Female students have increased their share of course enrollments only because female participation rates in math and science are declining less sharply then male participation rates.

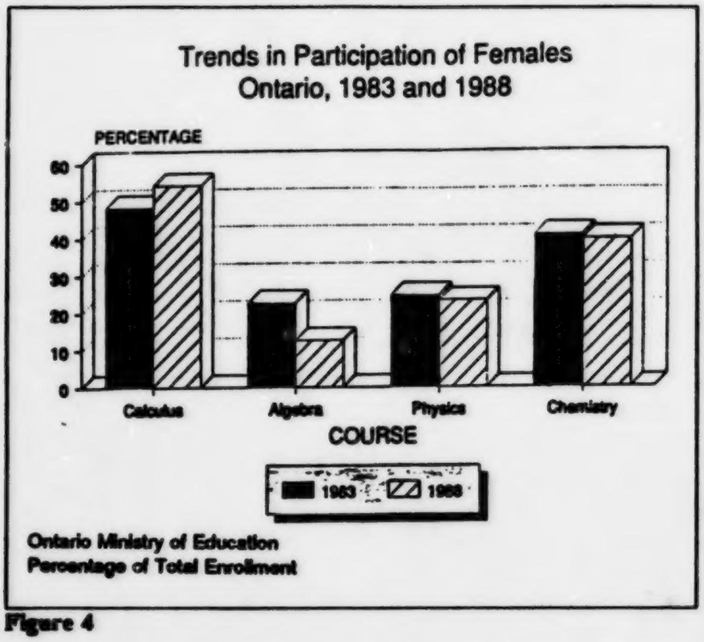
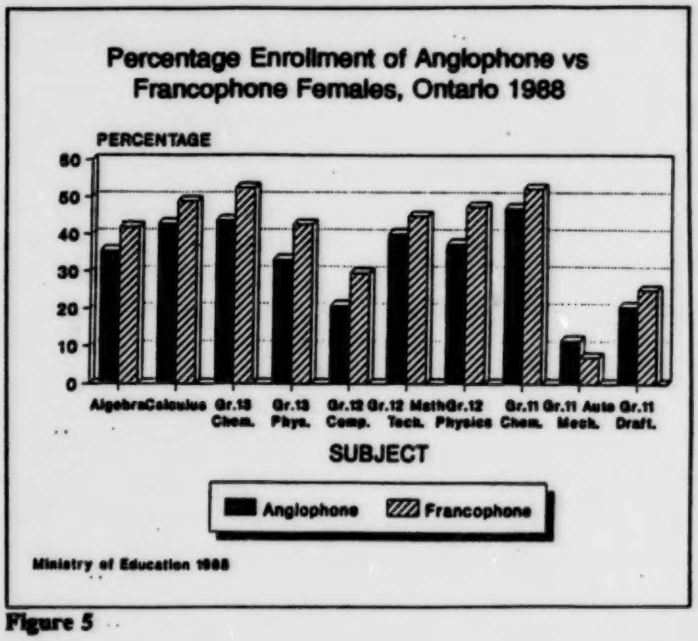


Figure 4

Cultural factors clearly impact on girls' participation as well. In French high schools in Canada there are proportionately more females in math and science classrooms than in English high schools (Haggerty, 1989). In Ontario, Ministry of Education statistics indicate that in 1988, 43% of francophone, grade 13 physics students were female as compared to 33% of anglophone physics students. There were similar differences in other math and science courses (Figure 5). Preliminary data from the Ministry of Education suggests that the higher proportion of females in Francophone math and science courses in Ontario is the result of both a **higher** participation rate for young francophone women (as compared with anglophones) and a **lower** participation rate for young francophone men. Anecdotal evidence suggests that young women of Asian background are also more likely than others to enroll in optional math and science courses.



Ministry of Education 1988

Figure 5

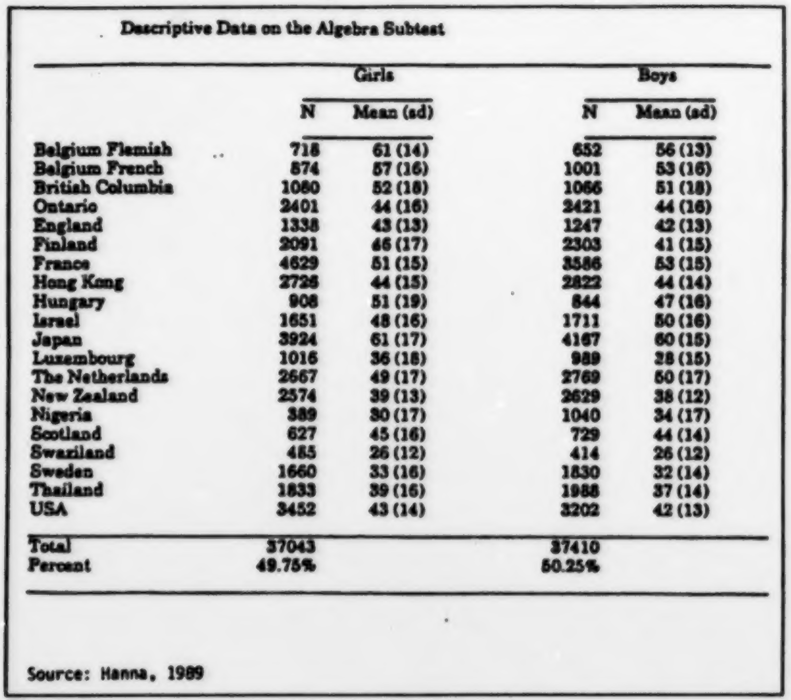
Why do young women drop out? Over the past twenty years we have learned a good deal about what is - and is not - responsible. Lack of ability, for one, is not the answer. In general, achievement levels for boys and girls in math and science are similar. According to Scott (1982), in Ontario the pass rate for grade 13 students in science and math is actually higher for girls than for boys. An international comparison of math achievement among grade 8 students in 20 countries found that, overall, there were no significant differences between boys and girls on the algebra, arithmetic and statistics sub-tests and a slight difference, which favoured the boys, in geometry and measurement, the subjects least taught in class. However, differences between countries were far larger than the gender differences (Figure 6). For example, both male and female students in Ontario received mean scores of 44 on the algebra sub-test while girls in Japan scored 61 and boys 60. Hannah (1989) concludes:

> "The . . . results suggest that for young adolescents sex differences in mathematics achievement are not important, that such differences vary from country to country, and that they are at most very small. . . . The implication is that sex differences at this age are due to out-of-class experiences and psychosocial processes, and not to biological differences."

As for just what specific psychosocial and cultural factors ARE responsible for the dropout rates, the answer is less clear cut. We are faced with multiple causes, which sometimes seem overwhelming in their diversity and complexity. What is clear is that the problem must be viewed in the larger context of the chilly classroom climate for all female students, a widespread though frequently unconscious, pattern of differential treatment by educators and others which reinforces biased assumptions about appropriate roles for males and females. Overall, this empowers males and diminishes the self-confidence of females, particularly in areas such as science, math and technology which are stereotypically male (Sadker and Sadker, 1982).

A secondary factor is deficiencies in the science and mathematics curriculum which "turn off" both males and females. Ontario has the lowest overall participation of male and female high school students in science courses of any province in Canada (Haggerty, 1989) and the long term trend is further downwards. Recent (1990) statistics from the Ontario Council of Universities indicate that only 13 percent of that year's high school graduates have selected science as their first choice of study (Ainsworth, 1990). There is evidence that "bad" teaching in science and math is particularly detrimental to female students and can increase the gender gap (Cole, 1990).

It should be noted that there are also other groups "at risk" for dropping science, mathematics and technology. In particular, children of visible minorities and those from low income families are often steered away from academic courses and are under-represented in the ranks of MMSET professionals. Girls from such backgrounds are doubly disadvantaged and are less likely than other girls to aspire to "non-traditional" careers (Avebury, 1986).



Descriptive Data on the Algebra Subtest

	Girls		Boys	
	N	Mean (sd)	N	Mean (sd)
Belgium Flemish	718	61 (14)	652	56 (13)
Belgium French	874	57 (16)	1001	53 (16)
British Columbia	1080	52 (18)	1066	51 (18)
Ontario	2401	44 (16)	2421	44 (16)
England	1338	43 (13)	1247	42 (13)
Finland	2091	46 (17)	2303	41 (15)
France	4629	51 (15)	3586	53 (15)
Hong Kong	2726	44 (15)	2822	44 (14)
Hungary	908	51 (19)	844	47 (16)
Israel	1651	48 (16)	1711	50 (16)
Japan	3924	61 (17)	4167	60 (15)
Luxembourg	1016	36 (18)	989	28 (15)
The Netherlands	2667	49 (17)	2769	50 (17)
New Zealand	2574	39 (13)	2629	38 (12)
Nigeria	389	30 (17)	1040	34 (17)
Scotland	627	45 (16)	729	44 (14)
Swaziland	485	26 (12)	414	26 (12)
Sweden	1660	33 (16)	1830	32 (14)
Thailand	1833	39 (16)	1988	37 (14)
USA	3452	43 (14)	3202	42 (13)
Total	37043		37410	
Percent	49.75%		50.25%	

Source: Hanna, 1989

Figure 6

In the following discussion, we detail some of the specific barriers girls encounter in their early years. Happily, a great deal is known about successful intervention techniques, and we follow by highlighting some of these these programs. We focus on the school system in particular because this is the arena most studied. Also, research indicates that good schools can make a tremendous difference in levels of student achievement, particularly among disadvantaged students (summarized in Landsberg, 1990).

A) TEACHER BEHAVIOUR

Teachers profoundly influence the attitudes, participation and achievement of students. Unfortunately, research indicates that teachers, unconsciously, have different sets of expectations, behaviour standards, rewards and punishments for female and male students and that these behaviours may be related to female participation in math, science and technology. Although much of the research quoted is a decade old there is abundant evidence to suggest that the findings are true for many (but not all) classrooms today. They are true for most men and women teachers.

i) Differential Treatment

Many studies have shown that, in general, teachers interact more with high achieving, white, male students than other students. In elementary school classrooms, boys have more interactions, and different interactions, then girls. They are reprimanded more than girls but they also receive more praise, more direct instruction, are listened to more frequently, asked "higher order" questions and are rewarded more for creative behaviour (See Figure 7).

Similar findings have been reported at the secondary level. One study in a mathematics class (summarized by Meyer, 1989) found that 70% of the encouraging comments were directed at males while 90% of the discouraging remarks were directed at females. Overall, girls received less of the teachers' attention than did boys, a very important factor when we consider that the teachers' attention is the single most valuable commodity in the classroom.

	Boys	Girls
Praise for Academic Work	Approximately 90% of praise is for intellectual quality	Approximately 80% of praise is for intellectual quality
	Approximately 10% of praise is for following rules of form	Approximately 20% of praise is for following rules of form
Criticism for Academic Work	Approximately 50% of criticism is for intellectual adequacy	Approximately 90% of criticism is for intellectual adequacy
	Approximately 50% of criticism is for failure to obey rules of form and other non-intellectual factors	Approximately 10% of criticism is for failure to obey rules of form
	There is frequent attribution to effort (you can do better if you try harder)	There is infrequent attribution to effort

Figure 7 Source: Sadker and Sadker, 1982

ii) Evaluative Feedback

Not only do boys receive quantitatively more feedback in the classroom than girls, but the feedback is qualitatively different as well. Failure feedback given to girls is usually for intellectual inadequacy, rather than lack of effort or poor form as it is for boys. For example, if a male student does poorly on an assignment the teacher may criticize him for sloppiness or lack of effort ("You did those problems incorrectly, Brian, I know you can do better if you try harder") while a female student might be told ("You did those problems incorrectly, Melissa, you don't seem to be able to grasp this material").

The result is a general lowering of self esteem among girls and the development of what Carol Dweck and her colleagues call "learned helplessness". **Learned helplessness** exists when failure is perceived to result from factors beyond a child's control. Girls are more likely than boys to blame poor performance on lack of ability rather than effort and to give up after receiving negative feedback. In experiments with fifth grade children, Dweck and her colleagues demonstrated that with both boys and girls, the type of failure feedback usually received by girls (which impugned their intellectual ability rather than effort or neatness) promoted learned helplessness in both genders (Dweck et al., 1978; Erhart and Sandler, 1987).

The phenomenon of learned helplessness, while it effects all aspects of girls' education, is likely to have particular relevance to "difficult" subjects like math and science, in which a good deal of persistence and problem solving is required for success.

Positive evaluative feedback also differs for males and females, but in the opposite way. Boys' superior performance is attributed to intellectual ability and girls' to extraneous factors like neatness or diligence. One recent (1988) example: at an Ontario high school graduation attended by one of us, the teachers had prepared brief tributes to all the Ontario scholars in the graduating class. Without exception, the boys were described as smart, ambitious and "going places", even though many broke the occasional school rule (this was often presented humorously). The girls, on the other hand, were depicted quite differently, as sweet creatures who obeyed the rules and had pleasant smiles.

iii) Sex role stereotyping

Teachers' use of **sex role stereotyping**, while frequently unconscious, also has a detrimental impact on girls' enrollment and performance in "non-traditional" courses. In one Ontario study, 40% of teachers agreed strongly with the statement that it is more important for boys to learn about computers than girls (summarized by Moore, 1986). Tasks and groupings assigned by teachers are often based on such stereotypes about appropriate male and female behaviour. Boys are asked to carry books or move furniture (even though, in elementary school the girls are often bigger and stronger!), operate audiovisual equipment, or demonstrate the computer. Girls are asked to take notes or erase the board. Again, the message given is that girls are not competent in physical or mechanical work.

iv) Overhelping

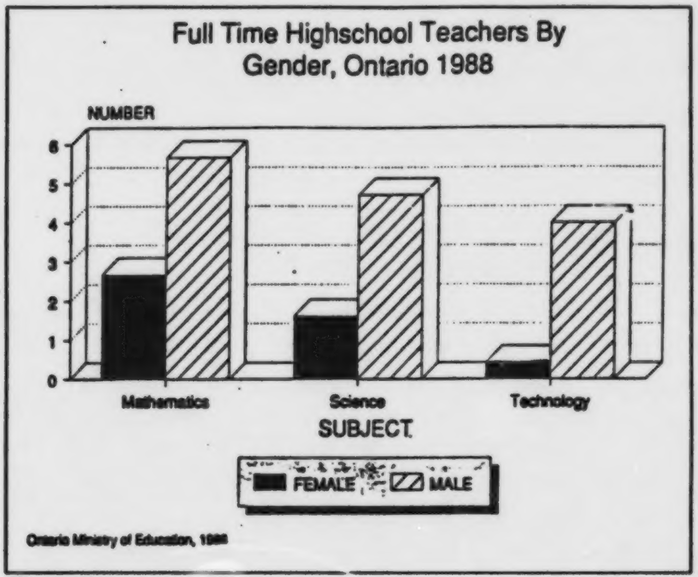
"Overhelping" of girls is also pervasive. The research shows that teachers are unlikely to tell Michael how to focus his microscope in biology class but to do it for Andrea. While the intent may be admirable, the message conveyed is not: Andrea learns that her teacher believes her incapable of handling the microscope herself, doubtless she is so clumsy she will break it. Of course, this approach is self-fulfilling, Andrea will not learn how to operate her microscope, will lose self confidence, and will be forever reliant on someone else to do it for her. Again, the results are particularly destructive in science and technology classes, where girls often lack the outside experiences ("tinkering", handling tools and machinery, use of computers) that boys bring to the classroom. Girls actually have a GREATER need than boys for hands-on, do-it-yourself experience.

v) Teacher Attitudes Towards Math and Science

According to the Science Council of Canada (1984), more than twenty-five percent of elementary teachers would prefer not to teach any science at all and only twenty-five percent had taken any university level science courses. One typical quote from an elementary school teacher-in-training: "My idea of science was a nerdy man in a lab" (Koch, 1989). Similarly in mathematics, one study found that pre-service elementary education majors scored higher on the Mathematics Anxiety Rating Scale than any other group tested (Jeffrey, 1988).

One danger is that math - or science - anxious teachers could perpetuate such anxiety in their own classrooms, particularly with girls who would be more likely to identify with female teachers.

In secondary school the situation changes dramatically. Most math, science and technology teachers specialize in one or more of these areas and have, in general, both knowledge and more positive attitudes than elementary teachers. The gender of science, math and technology teachers in Ontario high schools is still overwhelmingly male (see Figure 8). Girls who complete their secondary education without encountering a single female math, science or technology teacher are receiving a strong message about what is - or is not - a woman's field. Also, girls are less apt to be "mentored" by male than by female teachers.



Ontario Ministry of Education, 1988

Figure 8

B) OTHER BARRIERS

i) Textbooks and Instructional Materials

Textbooks are treated as the authoritative truth by many teachers and students. Subtle messages conveyed - through language, illustrations, content and questions - are all the more damaging because they are often absorbed without questioning.

Many studies in Canada and the United States have found that males are consistently over-represented in stories, pictures and problems in textbooks. Females, when depicted, usually appear in stereotyped roles and display such traits as dependency, passivity, fearfulness, concern about physical appearance and obedience. It appears that the exclusion of women from textbooks and other materials, the use of language which excludes women, and the failure to integrate women's experiences contribute to female students' perception of themselves and their gender as peripheral and inferior (summarized in Sadker and Sadker, 1982 and Wiggan, 1982).

Mathematics and science textbooks reinforce the perception of these fields as male domains. The contributions of women are rarely mentioned and the problems and examples reflect predominantly stereotyped interests and occupations. A recent OAC Physics text in Ontario features a group of male bicycle racers on the cover.

In Ontario, the Ministry of Education requires that books listed in Circular 14 (a document which lists all publications that can be used as textbooks in Ontario schools) must meet specific guidelines on gender equity, for example, with respect to non-sexist language, illustrations and examples. There are also guidelines for software. Although progress has been made in the past 15 years, it appears that some bias remains and many of the changes may be more cosmetic than substantive. According to a recent Canadian report (Status of Women Canada, 1989), "the extent of the incorporation...of the realistic portrayal of the current role of women and of their contribution to society (is unclear)".

ii) Curriculum and Curriculum Requirements

Curriculum refers to the plan of study for students in a particular school: the courses they take, the form and content of the courses and the methods by which they are taught. All of these affect the participation and achievement of girls in science, math and technology courses.

Course selection is an important factor at the secondary level. Girls who drop math and science courses in high school are drastically foreclosing their career opportunities later. According to the Canadian Teachers' Federation *Idea Book* (Robertson, 1988), such courses act as a "critical filter", because students who have not successfully completed them will find up to 85% of post-secondary programs closed.

Course selection is a prime example of a situation where a seemingly gender neutral organizational change - raising or lowering the age when subject selection begins - can have dramatically different effects on boys and girls. In Australia, lowering the age at which subject choices were made resulted in sex-stereotyped selection at an earlier age (Rennie and Parker, 1989). Conversely, in the U.K., the proportion of girls studying science doubled when physical science became a required subject for all students through the age of sixteen. A report on *Girls and Women in Education* by the Organization for Economic Co-operation and Development - OECD (1986) surveyed enrollments in 24 OECD countries in Europe, North America and Japan. The report concludes:

> "Where subject choices can be postponed until the minimum school-leaving age, the likelihood of girls choosing physical science, mathematics and technology is increased considerably. . . . Postponement of choice may well be a necessary prerequisite, if not a sufficient one, to bring about greater equalization of the sexes in different educational programmes and occupations."

Course content and methodology are also important, because in math, physical science and technology courses they frequently make it difficult for girls to relate to the subject matter. Typically, such courses ignore the contribution of women to these fields and use examples and problems more relevant to boys (e.g., in physics, car engines or football). Equally important - but more often overlooked - are the methods used to teach math science and technology. Recent work by Carol Gilligan (1989), Belenkcy (1986) and, in Canada, Susan Booth and Carol Brooks (undated), suggests that many girls are relational learners who learn best when they can relate their learning to their own life and have the opportunity to verbalize and interact with others. Unfortunately, math and sciences are rarely taught in such ways. The focus is on abstract principles not concrete examples and, particularly in math, on individual learning and competition rather than cooperative activities. Recent work by Meyer (1989) suggests that competitive classroom math activities (such as the game "Around the World") were related to lower mathematics achievement for females and that for cooperative activities the situation was reversed.

The use of timed, multiple choice tests also disadvantages women. For example, although males traditionally achieve better marks than females on the U.S. math SAT tests (a college entrance exam), researchers have found that the gender difference disappears when students are allowed to work at their own pace (Mandula, 1990). A recent report from the U.S.-based National Coalition for Women and Girls in Education (1990) urges the abolition of such tests.

iii) Career Guidance and Counselling

Both boys and girls need counselling that is free from stereotyped expectations, but guidance counsellors, like teachers, often have different career expectations for females and males. Young women not only avoid science and math, they avoid life-planning as well. They frequently reject the reality that they will spend most of their lifetime in the workforce and the possibility of becoming a single, sole-support parent.

In the past 15 years there has been progress made, particularly in terms of career guidance materials. A variety of posters, brochures and videos have been produced by the Ontario Women's Directorate and other concerned groups depicting women in a variety of challenging, non-traditional careers. Young women increasingly pay lip service to higher career aspirations though their expectations tend to be more traditional. For example, they may aspire to be doctors but expect to be nurses (Robertson, 1988).

We also know more about what makes for effective career counselling for girls and women. For example, Avebury (1986) report that teenage women are best motivated by the carrot rather than the stick approach - the primary message should be that non-traditional jobs are interesting, not that they are "good for them". These consultants also reported that career education should start well before puberty, when girls are most receptive to the message, and that puberty itself (between 11 and 12 years of age) was a critical time. Studies of women mathematicians also suggest that early career choice was a fundamental factor in their motivation (Wiggan, 1982).

But there is still a long way to go. It may be less blatant now, but the reality is that girls are still being steered into "feminine" fields and many guidance counsellors are ignorant of work place realities: Upper-middle-class, white female students are most likely to have non-traditional (professional not technical) career aspirations, while the lower the socioeconomic level the more susceptible the student to leaving academically oriented programs and aspiring to low status occupations (Robertson, 1988).

iv) Extracurricular Activities

Extracurricular activities, both within and outside of school, often provide experience and skills that reinforce basic assumptions about appropriate female and male roles, jobs, and behaviour. Boys' activities have traditionally been oriented to the development of creativity, leadership and physical prowess and they continue to dominate interscholastic athletics, science, math and computer clubs and competitions. Boys are also far more likely than girls to use computers: a study done in several Ontario schools found that 10 times as many males as females used computers during extracurricular time (Collis, 1990). Most computer games involve death, destruction and/or sports, which appeal more to boys than girls. Girls' activities, on the other hand, have focused on domestic skills and on helping or serving others.

Outside-of-school experiences also influence students' acquisition of scientific and mathematical skills. Many boys' activities give them a head start (for example, playing ball may promote an intuitive understanding of distance, space and direction) (Fischer, 1982). Also, as mentioned, girls frequently lack experience in tinkering and manipulation (for example, fixing a bicycle or a car).

v) The Media

Many children spend as much time in front of the television set as in the classroom, so the influence of the media on children's picture of the world can hardly be over emphasized. Though there have been some improvements, the picture of scientists and engineers presented on commercials, and children's television shows is still largely that of the wacky (or malevolent), male professor. A new hit television series featuring a swinging young female scientist in the lead role would probably create more of an immediate change in career aspirations of adolescent girls than all other initiatives combined.

A related problem is that reporters, like most Canadians, are often scientifically illiterate. At one science career day for girls, the (female) reporter covering the event made it clear to the girls that she had always disliked math and science and implied that there was something wrong with them for being interested.

vi) Parents

The differential treatment of boys and girls begins well before they enter school. Frequently parents, and society at large, encourage boys but not girls to play with manipulative toys such as construction sets or tool kits and various science-related activities. Educators at a Science Centre in Connecticut report that parents send fewer girls than boys (33 % less) to every program offered by the Science Centre (Rand and Gibb, 1989). In another study, when children were asked whether parents had encouraged them to use computers, 82% of the boys said "yes", compared to only 29% of the girls (Moore, 1986). Boys tend to pursue math because of parental expectations (Armstrong, 1979) that sons, but not daughters will pursue science, mathematics and technology-related careers.

vii) Peer Groups

It is clear that girls, particularly adolescent girls, are profoundly influenced by their peers. Although we found little research that specifically addresses the role of peers in course and career selection, it is undoubtedly an important one. For example, in one school the absence of friends in the computer course was found to be the most prominent factor discouraging computer use among girls. At another school, when asked what had changed their computer use, 50% of the girls ranked "seeing your friends use computers" as the most important factor (Moore, 1986). Enrichment programs, which in many school boards remove gifted students from their friends, may be counterproductive with adolescent girls.

C) INTERVENTIONS

Just as there is no one cause for the low participation of women in math, science and technology, there can be no simple, or singular, answer. The solutions must be as many—and as diverse - as the problem. But all interventions must address the finding that, for girls, **students' perceptions of the need for - and the usefulness of - math and science are the strongest influences on course taking plans** (Wiggin, 1982).

It is clear that **good schools can make a tremendous difference in students' achievements.** As Michelle Landsberg eloquently argues in *Education 2000* (1990), effective schools - schools which were small, personal and non-hierarchical, where students were frequently praised and supported and their parents closely involved - can overcome the disadvantages of race, class or sex. Specifically, **good teaching can narrow the gender gap in science and math.** In science, evidence from the U.S. Office of Technology Assessment suggests that good programs are particularly successful in closing the gap between women and minorities and their white male classmates (Cole, 1990). For math programs too, there is evidence that "good" teaching (active instructional involvement of teachers and students) has a positive impact on girls' enrollment in advanced math classes (Tsuji and Ziegler, 1990).

Secondly, **intervention programs can make a difference.** In the past decade, a wide variety of different initiatives promoting the increased participation of female students in science, mathematics and technology have been developed, adapted and/or implemented in many Ontario schools by dedicated educators and female professionals. There are many local success stories and some schools that have been very successful at nurturing female and minority students.

Unfortunately, many intervention programs also share a common problem. The work is often ill-funded, carried out by small numbers of dedicated educators and community members, and "patchy", both in time and space. Money or time for rigorous evaluations is rarely available.

Strategies to increase female participation can appeal to young women at one or more of three levels: cognitive (changed beliefs about the usefulness of science, mathematics and technology subjects); affective (increased confidence, decreased anxiety); and the ability or achievement level, such as improved spatial ability or grades (Tsuji and Ziegler, 1990). The three are closely linked, but some researchers have suggested that appeals to change at the affective and achievement levels have more impact on behaviour than a purely cognitive approach. Strategies also take a number of different approaches. The following discussion is not meant to be comprehensive, but only to suggest the diversity of approaches taken in Ontario and to point out some of the gaps.

i) Career and Role-modelling Programs

Perhaps the most common types of intervention are attempts to expose girls (and sometimes boys) to role-models, women in non-traditional careers. The Ontario Women's Directorate's role modelling programs, Pathmakers and Open Doors, provide older students and career women respectively for in-school career days, job shadowing, mentoring and other programs.

A popular variant of this approach are career conferences for girls in grades 7 to 12 which attempt to develop interest in math and science related fields by exposing students to female role models in non-traditional careers. Many also include hands-on sessions for students and talks for teachers and parents as well. In some cases these are organized by school boards alone (e.g., York, North York), in others by community colleges, universities, women teacher's associations or various combinations of the above. The *IDEA Book* (Robertson, 1988) lists 21 different organizations in 14 Ontario communities which sponsor career days and the actual number is probably larger still. In addition, the Strategies publication out of York University (Women in Science, Hopefully - W.I.S.H., 1988) lists 6 Ontario Universities, as well as Ryerson, offering special outreach programs for girls in math and science.

These activities are almost always highly rated by participants and there is a very special atmosphere generated, at once serious and very enthusiastic, a real "high" for students, organizers and speakers. If diverse groups are involved in the organization of a conference there is the potential for the formation of ongoing coalitions.

On the negative side, all-girl activities can sometimes create a backlash, usually from male teachers, students or their parents. Some boards handle this by including "disadvantaged" boys, others by having separate career days for boys. While it is true that positive changes in attitudes have been seen in male peers who participate in interventions alongside female peers (see Tsuji and Ziegler, 1990) coeducational career days should be used in addition to, not instead of all-girl sessions. The very special atmosphere of an "all girls day" - in which girls get ALL the attention - is crucial to their success. In the words of two 14 year old participants asked if boys should be included, "boys spoil the moment" and "boys aren't as serious as us".

There are certainly ways in which career conferences could be improved. Tsuji and Ziegler (1990) suggest that attempts be made to bring about attitudinal as well as cognitive change, by incorporating hands-on activities and by seriously examining the reasons girls may opt out of math and science (for example, the greater ease of success/grade reward in other courses). Integrating career day events with classroom activities would also be helpful in changing attitudes. Frequently, only a few girls from a given school are selected and teachers not directly involved in the conference may have the feeling that the school gets nothing back.

In addition, a wider range of career options which do NOT require university degrees need to be presented. Most girls will not wind up as engineers, doctors or Ph.D. scientists—they need to hear more about interesting and reasonably well paid jobs for technologists, apprenticeships, industrial sales, etc. Finally, research indicates that the use of role models close to participants in age (e.g., graduate or undergraduate university or college students or even high school students) would maximize conference effectiveness.

In this respect, the Toronto Board has recently (1989-90) experimented with a program which brings grade 7 and 8 girls into the workshops of technical high schools for a day of "hands-on" activities and interaction with female high school students enrolled in "non-traditional" programs. (This is a "one-time" event).

Finally, a major need is for long term follow up and evaluation of career day activities. Largely, we suspect, because of funding constraints, the long term impact of such programs has never been properly evaluated.

D) CURRICULAR INITIATIVES

i) Single Sex Programs

There is considerable evidence to suggest that girls in all-girls schools or all-girls classes have higher levels of achievement in math, science and technology than girls in coeducational settings. The most ambitious attempt in Canada to test this approach was a three year experiment with sex segregated advanced level mathematics classes (grades 10, 11 and 12) in a North York public high school. Female and male students, as well as a control group at another high school, were evaluated with respect to attitude (pre and post) and achievement. Overall, the board concluded that the segregated math program had little effect on the attitude or achievement of female students in mathematics (Sangster, 1988).

In spite of the Board's conclusion, we believe that the North York program did have some significant benefits. There was a large and statistically significant increase in the proportion of females enrolled in algebra (from 19% in year I to 48% in year III) at the experimental but not the comparison school (which increased by only 10%). Furthermore, evaluation of the results was complicated by the fact that, in the third year of the study, there were significant personnel changes, with four of the five female mathematics teachers leaving the school so that most female students were taught by male teachers. (It is ironic that two of the teachers left because they were declared surplus due to declining enrollments!).

It appears to us that there is room for additional experiments with single sex math classes and that the 250% increase in the proportion of females enrolled in grade 13 (now OAC) algebra in the "experimental" North York school is an important achievement. In Ontario there are (as of 1988) ongoing trial programs with sex-segregated computer courses (North York) and technology courses (public schools in Unionville, Brampton, London and Richmond; the Catholic school board in Waterloo region), but not with math courses.

It would also be useful to experiment with all female laboratories, or at least, with same sex lab partners. Observations of high school science labs suggest that, in mixed sex groupings, the boys do all the "experimenting" and manipulation of equipment and the girls assume a passive, note-taking role. On the other hand, with all-girl or all-boy grouping, both partners are more likely to be equally involved.

ii) Curriculum Reform

The curriculum interventions with the most potential include altering methodology to include more hands-on activities; cooperative rather than competitive learning and problem solving; interdisciplinary approaches (e.g., biology and physics or drama and science); and an emphasis on the real world uses - and usefulness of - science, math and technology. Biology courses should begin with humans not amoebae. The McClintock Collective in Australia (see next page) have pioneered this approach at the elementary and secondary level but, in Canada and elsewhere, it has been used mainly at the post-secondary level. For example, see the community college curriculum developed by Booth and Brooks (undated) listed in the Bibliography. A related approach, being pursued at several universities in the United States, is to institute far-reaching curriculum reform projects in which feminist analyses and approaches are being incorporated into mainstream curricula (Minnich et al., 1988). To our knowledge, nothing that ambitious has yet been attempted at the elementary or secondary level in North America, but it is certainly needed.

In Ontario, the newer Ministry of Education policy statements and curriculum guidelines support sex equity. For example, the 1985 Intermediate and Senior Mathematics Guideline highlights "math anxiety" and "careers and mathematics" as "cross-curricular components", draws attention to the lesser participation of female students in senior level math courses and includes a list of what teachers "should be" doing (Wiggan, 1988). Similarly, a policy statement for primary and junior level science, *Science is Happening Here*, contains a section on sex equity with a discussion of the problem and suggestions for teachers (Ontario Ministry of Education, 1988).

A variety of local initiatives now underway in Ontario seek to incorporate more female role models into math and science curricula (in terms of written and A.V. materials as well as outside speakers), to provide content which appeals equally to both sexes (for example, food chemistry) and to include "puttering" experiences. The IDEA Book (Robertson, 1988) gives examples of programs in Mississauga, Brampton and Chatham; probably many other teachers are trying out related activities in their classrooms.

Other countries provide models of well coordinated approaches to the development of gender-free curricula which may be worth emulating in Ontario. One outstanding example of such an initiative is the EQUALS programme at the Lawrence Hall of Science (University of California, Berkeley) which, since 1977 has produced curricula in addition to running in-service programmes for teachers and developing courses for children and adults (see W.I.S.H., 1988). For example, EQUALS developed the prototype career conference EXPANDING YOUR HORIZONS which is so widely used in Ontario.

Another model is the McClintock Science Collective, based in Melbourne, Australia. A network of science teachers and others committed to gender inclusive science education and to action within the schools, this non-hierarchical organization has developed a wide variety of new teaching strategies, for example, incorporating role-playing, drama and creative writing in science (Hildebrand, 1989).

iii) Teacher Training and Staff Development

As discussed above, the behaviour of teachers has a large impact on student attitudes and achievement. Good teaching seems to minimize gender differences and there is also some evidence of a link between teachers' math achievement and that of their students (Tsuji and Ziegler, 1990). Interventions focused on teachers are increasingly common.

A variety of such initiatives are being undertaken by various school boards and teacher organizations in Ontario, often in conjunction with other professional development or career conference activities. Examples include The Toronto Board of Education's Math-Science Network which organizes equity workshops and programmes such as "Job Site Visits" and the "Women and Mathematics" conference presented by the FWTAO (Federation of Women Teacher Associations) in 1987.

There is clearly a need for additional pre-service (i.e., at colleges of education) and in-service (professional development) training of teachers that would provide greater math and science content for elementary teachers and, for both elementary and high school teachers, exposure to appropriate, "girl-friendly" teaching strategies and ways of creating cooperative learning environments. Queens has recently announced new initiatives in the teaching of math teachers (French, 1990) and we would hope that this new program will focus on these crucial, gender-related issues.

Several U.S. teacher-training programs have adopted innovative approaches such as "master teaching". For example, one project in North Colorado will provide an intensive two-week workshop for rural biology teachers aimed at the development of an intervention program, for use in their classrooms, which they hope will improve the retention of girls (and boys) in science courses and careers. (See also Ravina & Rom, 1989).

Finally, employment equity can also be considered an intervention technique and requires continued emphasis. Though progress has been made, we are still far from parity and the continued predominance of male principals and senior administrators, in most boards, sends a strong and sexist message to female students. It also appears that the very teachers most apt to push for schools which will nurture girls as well as boys (e.g., feminists) may be the ones least likely to be promoted into positions of power by male superiors (Steed, 1990). So long as promoting the rights of girls is a negative factor in teachers' careers, progress towards equity for students will be slow.

At the pre-service level, we need to encourage more women to specialize in math, science and technology education; to remedy existing disparities, schools of education should perhaps be accepting equal numbers of male and female applicants (assuming that there is a large enough pool of qualified women). Schools of education should also be actively seeking and encouraging additional female graduate students and faculty.

E) EXTRACURRICULAR ACTIVITIES

i) School-based programs

A number of schools have developed or experimented with after school or Saturday programs for girls in math or science. These can be very effective: the year that one teacher in Waterloo County instituted an all-girls math club for grade 7 students, all of the top scorers in the Gauss competition, from that school were girls (this had never happened before at the school). Unfortunately, here, as in so many cases, there was no attempt to build on success or to recognize the teacher's achievement. She subsequently left the school and the program was discontinued.

A few school boards in Ontario have also developed special programs for parents, aimed at highlighting issues related to sex-role stereotyping in the workforce and the importance of math and science to their daughter's future. For example, the Toronto School Board has developed a special video for parents ("Math Counts, Science Matters") and also runs classes in "Family Math", an excellent 4 to 6 week course designed for parents and children, which includes a series of enjoyable math activities related to everyday life and teaches parents how to motivate and help their children with math at home. The Lincoln County Board of Education invites parents to sessions of its Saturday morning Ms. Math program. Another useful model is the WISM (Women in Science and Math) format developed by Norm Lee in Winnipeg, Manitoba (Lee, 1990). This is an outline for an evening workshop for parents and daughters (grades 4 - 8) which includes talks for the parents and hands-on activities for the girls. In view of the critical role parents play in their daughters' course and career selections, more boards should adopt such parent outreach programs.

ii) Non-school based programs

As mentioned, several Ontario Universities offer special outreach programs for high school girls. York University pioneered such initiatives and has developed a wide range of programs including Physics: A World of Opportunity, instituted by Dr. Jim Megaw and The Mathematics Colloquia (Real Women Don't Do Math) by Dr. Pat Rogers. Both are three day residential conferences.

We are not aware of any summer programs in Ontario specially geared to girls and science. There are, however two excellent summer programs for gifted high school students, The Shad Valley Programme at the University of Waterloo and the Summer Program of Science and Technology of Lakehead University. Both do make special efforts to provide female role models, as faculty and speakers, and attract many female students (the Lakehead programme, for Northern Ontario students, is actually evenly divided in terms of gender, a great accomplishment).

There are other possible models for science programs as well which might be worth emulating in Ontario. In Vancouver, the Society for Canadian Women in Science and Technology (SCWIST), runs a summer Girl's in Science Program for girls 9 to 12 years old which consists of a week of "hands-on" workshops covering activities like bicycle maintenance and ice cream making. In Edmonton Dr. Margaret-Ann Armour, at the University of Alberta, has organized a summer research program for grade 11 girls (and some boys) at the University. In the United States, the EUREKA program, based at Brooklyn College and financed largely by private foundations, offers a "science camp" for minority girls in grades 7 and 8. A unique aspect of this program is that, in addition to science and math., EUREKA promotes self-confidence and leadership skills through an intensive program of physical activity (for example, many of the girls don't know how to swim). There are also occasional Saturday programs during the year, for on-going support and networking, and the girls receive practice on writing the entrance exams for "selective" public high schools in New York City.

Another U.S. program which might be worth emulating in Ontario is Operation S.M.A.R.T. (Science Math and Relevant Technology), a national informal education program for girls ages 11-14 being developed by the Girls Clubs of America Inc. The program consists largely of after school sessions (a biology session is called "beyond yuck") and most participants are from low income families; ultimately most clubs (a total of 200,000 members) will be involved. Funding is from a variety of foundations, businesses, and the U.S. federal government (National Science Foundation, NSF). NSF is also funding the development of a Girl Scout (comparable to Girl Guides) leader training program that will provide science education experiences for Girl Scouts. The program is being developed by the Franklin Institute Science Museum.

One program unique to Canada is the Women Inventors Project. An independent, non-profit organization, the Project has developed a teachers' manual on conducting hands-on invention workshops for girls and a video on women inventors and also runs workshops on inventing for students and teachers.

iii) Science Centres

Science Centres are frequently under-used by women and minorities. Ulmanis (1986) suggests the creation of special "women's centres". This may not be feasible at the moment, but Science Centres need to review their existing displays and to develop special exhibits that will appeal to girls and women. Even more, there is a need for outreach programs and more community involvement with "underserved" groups. For example, Science North does have excellent community links and hosts annual "slumber" parties popular with girls and boys. They are also planning a series of Saturday workshops on inventing specifically for girls. Another worthwhile program pioneered by the Museum of Science in Boston is a Science pen pal programme which teams children with scientists in creative, problem-solving exercises. Such an approach would be ideal in Ontario in reaching children in Northern communities.

F) CONCLUSION

There is a need for a comprehensive and integrated approach to gender equity issues in mathematics, science and technology at the elementary and secondary level. The Ontario-based intervention programs detailed above are worthwhile efforts representing a tremendous amount of hard work by small groups of dedicated educators and others, But they are mostly isolated, short term efforts run on shoestring budgets. They often end when the teachers involved burn out, are laid off or move on to other assignments. Equity initiatives also vary across Ontario, with some school boards doing a great deal and others virtually nothing.

Better funding, co-ordination and follow-up for intervention programs as well as long-term commitments and support are required. There is also a need for more consistency in curriculum, equity and for better accountability. Benchmarks and targets need to be established at the provincial and local levels. Performance should be monitored and made public. For example, parents could be informed about the participation rates of female (and male) students in math, science, computer and technology courses in local high schools. Outstanding initiatives by individual teachers or schools should be recognized and rewarded. Improvements could be made in teacher education and in the awareness of curriculum equity issues among principals, superintendents and trustees. Curriculum equity is closely tied to employment equity and it is important to have more female math, science and technology teachers at the high school level. D activities in math, science and technology, particularly for disadvantaged girls, are needed. Finally, experience in other countries suggests that additional mandatory math and science courses will increase the numbers of females in MMSET careers.

The MMSET gender equity issues cannot be considered in isolation. We need the general changes to our elementary schools envisioned in *Education 2000 (1990)*. These included smaller institutions, less hierarchy and more parental involvement. We also need new approaches to science, mathematics and technology education in the classroom. The status quo is no longer an option, as, increasingly, boys as well as girls pursue other careers. Nothing less than a comprehensive and transformative approach will reverse the tide.

II. POST SECONDARY EDUCATION

> "the very best female science students are more likely than their "average" performing counterparts to defect from science, and in fact, it is the top academic performing female science students who report the highest seepage rate." (N. Nevitte, R. Gibbins and P.W. Codding, *The Career Goals of Female Science Students*, 1990).

> "do not accept that discourtesy which denies your talents to you. Never believe it." Emily Vermule, 1985, in an address to Harvard women graduates. (Quoted in Nadya Aisenberg and Mona Harrington, *Women of Academe: Outsiders in the Sacred Grove*. Amherst: University of Massachusetts Press, 1988).

A) BACKGROUND: THE PURPOSES OF POST-SECONDARY EDUCATION

Patterns of women's post-secondary education in MMSET must be seen in the context of the goals of the educational process. Post-secondary education in Canada serves two distinct but interrelated functions. Colleges and universities, often described as "ivory towers" or "sacred groves", have traditionally provided students with general knowledge and prepared the ground for academic teaching and basic, or "pure", research. But since the Second World War, Canadian post-secondary educational institutions have also been guided by the national goal of "creating economic prosperity" (Axelrod, 1982). As the recent report *Vision 2000: Quality and Opportunity* so eloquently notes:

> "Metaphorically, education is seen as the keystone of the arch connecting today to the information society and economy of tomorrow . . .Once again our educational system faces the challenge of facilitating a major social and economic transformation" (*Vision 2000, Interim Report*, 1988).

With these economic goals in mind, universities and community colleges have continually widened their curricula to provide students with the general and applied knowledge and with the practical skills demanded by an expanding workforce.

These broader economic goals have guided the general expansion of post-secondary education, and they have especially shaped education in the sciences. To a great extent, concerns about post-secondary education, particularly post-secondary scientific education, have been industry driven. Historically, as interest in the health of the Canadian economy grew, so did the number of students trained. As science and technology seemed to light the path of Canada's economic future, and the number of technical jobs was increasing, post-secondary institutions acted to ensure the interests of science. Community colleges tied the objective of preparing students for employment to increased opportunities in the technical trades by implementing numerous technical training programs. Universities, while struggling to ensure the interests of general humanistic education, could not ignore a powerful Western cultural tradition that emphasizes the power of science and equates technology with progress. They too responded to the argument that science and technology light the path to Canada's economic future, and to North American industry's lament that Canadians lack basic scientific and technical skills, by increasing the number of scientific places[2]. The number of undergraduate degrees awarded in MMSET increased more than ten-fold between 1944 and 1987. Between 1979 and 1984 alone, the number of science and engineering students increased 30% (from 83,478 to 108,892):[3] (Statistics Canada, *Education in Canada*).

Canadian politicians and students view post-secondary schooling as part of training. This is particularly true for the trades and professions, where education is seen to provide essential skills and academic qualifications. Hence, those who aim to increase women's participation in the labour force have first promoted women's education. And, aware that educational status correlates directly with participation in the workforce, those women who hope to work outside of the home have sought post-secondary credentials (Connely and Macdonald, 1990).

Much of the growth in the student body over the past two decades can be attributed to increased female enrollments. Women have formed a larger and larger part of the student body in all Canadian institutions of post-secondary education. During the 1970s and 1980s, as the number of undergraduate places in community colleges and universities increased, so did the number of women who occupied those places. A mere fraction of the student body during the 1940s and 1950s, women had come, in 1977, to occupy 44% of full-time undergraduate places; by 1987 they represented 50% of the full time students in Canadian universities, and they occupied 53% of the full-time places in community colleges (Statistics Canada, *Education in Canada 1987-88*: 41ff). Women have come to occupy an even larger percentage of the part-time undergraduate places, in both universities and community colleges. In 1987, they represented 63% of part-time community college students, and 59% of part-time university students. The percentage of women, among graduate students has also increased. In 1987 women represented 40% of full-time and 50% of part-time graduate students. (See Figure 9).

---

[2] Numerous articles on this subject include: "The future now: Canada lags behind in science and technology" *Macleans* (April 20, '87) 100:34; Doug Powell, "How is Basic Science Faring in Canada?" *Science* (March 9, 1990) 247:1172; Anthony P. Carnevale, Leila J. Gainer et al. "Workplace Basics: the skills employers want" *Training and Development Journal* (1988) 42:22; Shirley Strum Kenny, "College as gateway to a job" *Journal of Commerce* (Jan. 1990) 383:8A; Dan Troshynski, "Education and high-tech manufacturing," (Jan-Feb. 89) 64:43; Diane Francis, "New Concerns about the Brain Drain," *Macleans* (Feb 26, '90) 103:9; Rodney Hartnett, "Has there been a graduate student 'brain drain' in the arts and sciences," *Journal of Higher Education* (Sept-Oct. '87) 58:562; Barbara Wickens, "Seeking the best" *Macleans* (Nov. 20 '89) 102: 68; "Big Science, Big Thinking, The National Interest," Transcript of the A. W. May Address. *Vital Speeches*, (Dec. 1 '89.) 56:114; Earl V. Anderson, "Canada grapples with its science and technology policy" *Chemical and Engineering News* (March '89) 67: 7; Geraldine Kenny Wallace and Fraser Mustard, "From Paradox to Paradigm: the evolution of science and technology in Canada" *Deadalus* (Fall '88) 117:191; Angela Kryhul, "Set scientific research priorities, Canada urged at meeting of industry, labor and education leaders," *Metalworking News* (Feb 1, '88) 15:8; Angela Kryhul, "Canadian leaders urge shake-up of nation's R and D. Efforts," *American Metal Market* (Jan. 22, '88) 96:4.

[3] The statistics presented in this section of the report are derived primarily from analysis of the following sources: Statistics Canada. *Canada Yearbook*. Ottawa: Minister of Supply and Services: Volumes 1951-1989; Statistics Canada. *Education in Canada: A Statistical Review*. Ottawa: Minister of Supply and Services. Volumes 1980-81 and 1988-89; Statistics Canada. *Dimensions*. Ottawa: Minister of Supply and Services. Volumes 1980-81 to 1988-89; Ontario Ministry of Colleges and Universities. *Statistical Summary*. Toronto: Queen's Park. 1975-1989.

Percentages of women among college and university students, 1987

	Full-time	Part-time
Community College	53%	63%
Undergraduate	50%	59%
Graduate	40%	50%

Figure 9: Source: Statistics Canada, *Education in Canada*

The past two decades have also witnessed a change in the goals of college and university bound female students. A recent American study reports that female students usually attended post-secondary institutions, during the 1950s and 1960s, for the purpose of acquiring general knowledge or a spouse; women now enroll in colleges and universities "for reasons similar to those of men." They attend colleges and universities primarily to acquire "career preparation". (Cantwell, 1990; "No More MRS degree", 1987). Similar patterns hold true in Ontario, where women attend colleges and universities to improve their job skills and qualifications (Kenny, 1990).

Women's greater presence in colleges and universities is not uniform, however. In Canada, it varies across regions or disciplines. These variations in achievement are most apparent in the sciences, where they can be seen at community colleges and in undergraduate and graduate university degree programmes.

B) COMMUNITY COLLEGES

Roughly 40% of Canadians, a majority of them women, receive post-secondary education at community colleges. Though enrollments in community college programs have declined across Canada, by approximately 11% since 1983, the number of women students has remained high. Women community college students have held their ground both in terms of absolute numbers and as a percentage. Over the past decade, women have come to represent an increasingly large percentage of the student bodies at community colleges, in part because these institutions are attracting older students and fewer men (Statistics Canada, *Education in Canada; Women in Canada*, 1990).

Community colleges specialize in technologic training. In 1986-7, engineering technologies and secretarial science represented the two most popular programs of pre-employment study and skills-upgrading. Roughly 90% of registered apprentices were concentrated in courses in engineering technologies and electrical/electronic technologies. Still, despite the emphasis on MMSET and the preponderance of women in community colleges, females comprise a small proportion of the students to whom they award technical degrees (Statistics Canada, *Education in Canada; Women in Canada*, 1990).

A recent report by Statistics Canada noted that "almost 50% of the males graduated in engineering and applied sciences and 21% in business. Female graduates were more evenly distributed among the various fields; the top three were: business and commerce (32%) health sciences (29%) and social sciences (19%)" (Statistics Canada, *Education in Canada*, 1987-1988). Hidden beneath this veneer of "well-rounded" interests is the very uneven participation of female community college students in MMSET. In 1987, 43% of the men enrolled in community college programs studied engineering technologies; a mere 10% of women did (Statistics Canada, *Education in Canada*, 1987 - 1988).

Nor have women moved to fill the gap left by the male students who have chosen not to attend community colleges. As the proportion of male students has declined, so has the number of engineering degrees. The 11% decline in community college enrolments, reported for the period 1983 to 1987, was primarily a drop in male candidates. Even when the males are gone, female community college students continue to flock to "traditionally female" areas of employment. As male enrollments decreased, so did enrollments in technology programs. Between 1983 and 1987, enrollment in pre-employment technology programs decreased almost 20%. And as female enrollments increased, enrollment in secretarial science jumped from 11% to 16% (Statistics Canada, *Education in Canada*, 1987-1988).

With the exception of chemical technologies, natural science, resource processing technologies, and the female dominated area of health science technology, women comprise less than 30% of the students in any technologic career program offered at Ontario's community colleges. The percentage of women involved in most of these programs increased slightly, but not significantly, during the 1980s. These trends are consistent with those seen Canada-wide, where the number of female, community college graduates in the health sciences - and even nursing - has actually fallen over the past decade (*Women in Canada*, 1990). Still, it is worth noting that, in Quebec, women generally comprise a larger percentage of students enrolled in full-time, technical, career programmes at community colleges. (See Figure 10).

C) INSTITUTES OF TECHNOLOGY, TRADES AND VOCATIONAL PROGRAMS

Significant numbers of Ontarians also obtain post-secondary education at institutes of technology and in trade and vocational programs. These programs provide pre-employment training, skills upgrading and registered apprenticeships in the major commercial and technical trades. Over the past decade, Canadian women have increased their participation in trade and vocational programs of study, but these levels remain absolutely low. They are particularly low when contrasted with gains made in other areas of post-secondary education. Canada-wide, 39,000 women, representing only 37% of all graduates, graduated from trade and vocational programmes in 1987. Few of these women had enrolled in programs most geared to employment in the technical trades. Women represented 41% of students in pre-employment programs; 36% of students in skill-upgrading courses, and 3% of registered apprentices. Women have tended to concentrate in orientation and basic job-training programs (*Women in Canada*, 1990; Statistics Canada, *Education in Canada*; Mori and Burke, 1989).

% Women Full-time Enrollment in Career Programs of Community Colleges

	1982-3	1985-6	1987-8		
			Can.	Ont.	Quebec
ARTS	55.8	55.66	57.15	51.5	70.0
ARTS AND SCIENCE	57.3	56.88	58.0	59.9	NA
ENGINEERING & APPLIED SCIENCE					
Chemical Tech.	39.7	41.5	40.0	41.16	48.0
Comp. Sci.& Math.	44.9	33.6	29.2	27.00	28.0
Electrical & Electronic Tech.	3.3	4.3	4.6	4.5	5.58
Engineering Tech.	8.5	9.0	10.3	8.05	13.48
Transportation Tech.	10.7	10.1	11.5	10.9	14.59
HEALTH SCI. TECH.					
Health Related Tech.	69.0	72.8	71.36	62.3	82.4
Nursing	92.4	90.0	89.0	91.8	83.9
ENVIRONMENTAL & CONSERATION TECH.	26.6	23.9	25.3	12.86	43.3
NATURAL SCIENCES	41.4	43.0	47.0	48.82	41.19
PRIMARY INDUSTRIES	13.6	11.5	11.5	11.4	11.4
RESOURCE PROCESSING TECH.	28.0	35.0	31.5	47.22	34.2

Figure 10 Source: Stastics Canada

% of Women Students: Undergraduate Enrollment - Full Time

	1980-81			1983-4			1987-88		
	Can.	Ont.	Que.	Can.	Ont.	Que.	Can.	Ont.	Que.
Arts	54.49	54.93	53.87	55.76	57.11	53.68	60.42	62.8	60.0
Science	38.28	39.75	39.27	38.02	39.57	38.94	27.78	29.46	30.28
Ag. & Bio	35.45	34.84	38.35	37.11	32.19	46.15	37.92	33.0	50.0
Commerce	37.12	39.92	32.94	42.52	45.52	40.29	44.17	43.1	48.6
Eng. and App. Sci.	9.65	10.17	10.02	11.55	11.55	13.15	11.8	11.3	14.68
Env. Studies	35.06	37.76	35.14	34.42	33.71	37.47	NA	NA	NA
Dentistry	20.71	17.9	25.81	26.19	20.59	34.98	34.8	28.85	44.15
Medicine	36.04	32.61	41.89	41.84	40.13	46.68	44.88	40.42	52.9
Misc. Hlth. Profs.	82.47	75.85	81.19	82.9	76.27	81.7	57.69	46.68	71.0
Nursing	97.0	97.85	90.53	96.79	98.02	90.77	94.6	96.3	88.0
Pharmacy	63.7	48.88	56.43	67.21	68.58	66.03	63.89	66.25	72.27
Household Sci.	97.12	96.02	94.77	96.36	93.39	90.36	92.2	89.0	91.4
Vet. Med.	46.87	46.35	51.71	54.13	54.24	53.11	60.0	59.0	64.0

Figure 11

At the trades and vocational level, students' choices of course specialty are further stratified by gender. The increase in female enrollments at the trades and vocational level has not produced a diversity in student interests any more than it did at the community colleges. Women continue to concentrate in "traditionally female-dominated" fields of study. Canada-wide, four of every five male students who enrolled in trades programmes graduated in the engineering technologies or trades (Mori and Burke, 1989). These fields included electrical construction, heavy and agricultural equipment mechanics, air conditioning and refrigeration mechanics, automobile mechanics, mechanical engineering technology, welding technology, and power and stationary engineering technology. Women represented fewer than ten percent of graduates in any of these fields. Overall, only 6% of women graduates from institutes of technology, or trade and vocational programmes, majored in the engineering technologies. Despite economic indications that degrees in these technical subjects translate into high-labour force participation and good wages, women instead chose courses in commercial and secretarial programmes (Mori and Burke, 1989). The percentage of women who completed technological courses at trade and vocational schools actually declined, Canada-wide, from 7% in 1983-84 to 4.9% in 1986-87. In contrast, the percentage of women who completed secretarial and commercial programmes increased. Only the health science and technological fields attracted significant and increasing numbers of women (Mori and Burke, 1989; *Women in Canada*, 1990).

D) UNIVERSITIES: UNDERGRADUATE EDUCATION

More Canadian women enrolled in and completed post-secondary scientific studies during the 1970s and 1980s, but women's gains in these areas have not kept pace with gains in other fields. By the 1980s, women had come to represent at least 50% of all Canadian undergraduate arts students, but they regularly represented fewer than 40% of science major students. (See Figure 11). Moreover, while the number of women undergraduate arts students increased steadily during the 1980s, between 1983 and 1988 the percentage of women enrolled in scientific programs actually decreased.

(i) Full-time Undergraduate Enrollments

Declining female enrollments can be seen across fields. Whereas, in Ontario in 1980, women represented 35% of the full-time undergraduate students enrolled in agricultural and biological sciences and 39.75% of all full-time undergraduate science students, in 1987, they represented, 33% of full-time undergraduate students in agricultural and biological science and 29.5% of science students. (See Figure 11). This decline in female enrollments in the agricultural and biological sciences might be an artifact of reporting techniques. Until recently, household and domestic science were included within the heading "agricultural and biological sciences," thus inflating women's representation within these disciplines. But even after the reporting techniques were altered, the statistics showed that women still participated more in the agricultural and biological sciences than in the "hard," physical and applied sciences.

Female enrollments in other disciplines have barely remained constant. While some studies report that the percentage of women in the engineering and applied sciences has increased since the mid 1980s, (Baigneé, 1990), others note a levelling off or decrease. Any gains reported in the percentage of female students in Engineering and Applied Science, Dentistry, Medicine and Pharmacy, must also be interpreted with caution.

Ontario diverges marginally from the national trend. Between 1980-81 and 1987-88, the number of women who began undergraduate courses of engineering, at Ontario universities increased by 241 places, or almost 20%. Still, any increase in women's participation in engineering must be seen in the context of a significant decline in male and in overall enrollments. In 1980-81, 17,923 Ontario students enrolled in Engineering and Applied Science, of which 16,100 were male; by 1987-88, total enrollments in engineering and the applied sciences had declined to 13,862, of whom 12,295 were men. (See Figure 12).

Significant regional differences also exist, and gains made at one school are sometimes offset by losses at another.

Changing Patterns of Male and Female Enrollment in Engineering, Ontario 1980-81 to 1987-88

	1980 - 1981	1987 - 1988
Male	16,100	12,295
Female	1,823 (10%)	1,567 (11.3%)
Total	17,923	13,862

Source: Statistics Canada

Figure 12

ii) Part-time enrollments

Patterns of women's enrollment in part-time, undergraduate, scientific study are equally uneven. Science has not been traditionally tied to part-time study. Fewer part-time undergraduate students have, as a group, enrolled in science courses. Here too, however, variations exist across fields. Across Canada, the representation of females, in part-time scientific studies, declined between 1983 and 1987; within Ontario, the representation of females declined from 43% in 1983 to 26% in 1987. A less gloomy picture emerges, however, when one breaks the sciences down into fields, and small gains even emerge. Canada-wide, and in Ontario, the percentage of women among part-time students has increased marginally in agricultural and biological science, in engineering and applied science. (Figure 13).

These gains must be interpreted cautiously for many of the same reasons noted in the above analysis of changes in full-time undergraduate education: the numbers are often very small, they must be interpreted in the context of gender trends in enrollment. Regional variations persist, and the categorization of disciplines can sometimes artificially inflate or mask the numbers of women. Still, even slight increases in part-time enrollment might be indicative of a "steady-state" in female enrollments as women shift into programs of study that allow them to combine education with other experiences.

The declines in full- and part- time undergraduate enrollments that have occurred in Ontario reflect, general Canada-wide trends. They are also consistent with patterns identified across North America (Solomon, 1989). However, it is worth noting, that, once again, the

PERCENTAGE OF WOMEN STUDENT:
PART-TIME UNDERGRADUATE ENROLLMENT

	1980-81			1983-4			1987-88		
	Can.	Ont.	Que.	Can.	Ont.	Que.	Can.	Ont.	Que.
Arts	67.21	70.68	67.66	67.61	69.98	69.7	69.5	54.7	51.0
Science	42.59	39.11	41.49	42.73	43.61	41.97	32.3	26.5	37.42
Ag. & Bio.	36.09	40.34	39.33	40.51	48.0	46.67	44.86	50.0	60.0
Commerce	37.81	45.68	38.02	46.24	48.69	45.25	53.0	50.0	54.0
Eng. and App. Sci.	7.16	8.58	5.69	8.66	9.32	7.78	10.65	10.4	9.8
Env. Studies	48.34	25.98	53.63	36.0	33.88	34.71	NA	NA	NA
Dentistry	52.63	16.67	75.0	44.44	40.0	50.0	53.0	0.0	50.0
Medicine	51.74	50.0	51.22	59.74	100.0	57.35	53.0	46.0	56.0
Misc. Hlth. Profs.	79.38	80.0	68.1	63.97	83.33	55.81	71.5	47.25	72.36
Nursing	94.8	95.55	93.53	95.69	96.9	94.82	95.0	96.0	93.0
Pharmacy	65.53	79.25	59.09	57.86	62.16	44.83	63.0	71.42	60.0
Household Sci.	90.22	97.88	92.05	95.25	95.02	96.91	93.8	92.12	95.0
Vet. Med.	50.0	0.0	50.0	66.67	66.67	0.0	50.0	40.0	66.66

Source: Statistics Canada

Figure 13

percentage of women enrolled in scientific courses has fallen much more sharply in Ontario than in Quebec. In Quebec, women now comprise 50% of students in the agricultural and biological sciences and 30% of full time science students (Figure 11). Moreover, in Quebec, women comprise much larger percentages of the full and part-time undergraduate student bodies in Engineering, Dentistry, Medicine, Pharmacy and Veterinary Medicine. Between 1981 and 1987, the number of full-time female students enrolled in programs of engineering at Quebec universities increased from 10% to 14%; in dentistry from 26% to 44%; in Medicine from 41% to 52%., and in pharmacy from 56.5% to 72% (See Figure 11). These provincial differences indicate that cultural variables affect women's patterns of scientific education.

E) UNIVERSITIES: GRADUATE ENROLLMENTS

i) Full-Time Graduates

Canada-wide, full-time graduate enrollment increased by almost 40% during the 1980s, and the percentage of women increased accordingly. By 1987, women had come to represent

41% of all full-time graduate students enrolled in Ontario universities. This amounted to an almost 30% increase over the figure (32%) reported a decade earlier. As a group, full-time female graduate students have not yet reached parity with their male colleagues, but they have come to dominate some fields. Women, as might be expected, have made significant gains in education and the humanities, where they represent, respectively, 69% and 54% of full-time graduate students (Statistics Canada, *Education in Canada*).

Full-time Graduate Enrollment

	1980-81			1983-4			1987-88		
	Can.	Ont.	Que.	Can.	Ont.	Que.	Can.	Ont.	Que.
Ag.	35.62	37.82	35.84	35.95	36.4	31.17	39.0	37.6	43.0
Eng. and App. Sci.	9.57	9.82	8.57	10.35	9.6	10.97	12.4	11.6	12.47
Hlth. Profs.	34.18	33.55	35.53	37.06	36.42	57.34	41.2	40.9	44.9
Math. and Phys.	16.71	15.48	18.51	18.99	19.75	20.22	20.4	20.2	23.49

% Women Part Time Graduate Enrollment

	1980-81			1983-84			1987-8		
	Can.	Ont.	Que.	Can.	Ont.	Que.	Can.	Ont.	Que.
Ag.	34.89	26.94	44.13	39.53	38.65	43.22	48.42	51.0	46.62
Eng. and App. Sci.	7.35	7.51	7.52	9.29	9.74	9.67	11.0	10.2	12.71
Hlth. Profs.	57.52	57.37	55.96	62.78	60.12	61.15	65.8	60.0	61.45
Math. and Phys.	15.6	15.55	18.84	20.7	19.60	22.59	22.15	21.0	23.79

Source: Statistics Canada

Figure 14

Women graduate students have also fared well in some of the sciences, but their status in others has remained static. The percentage of women enrolled as full-time graduate students in the agricultural and biological sciences in Ontario, was virtually unchanged between 1980 and 1987. Women's participation in graduate studies, in the health professions increased from 33.5% in 1980 to 40.9% in 1987-88 (See Figure 14).

However, as was the case among undergraduates, women still represent a very small fraction of students enrolled in full-time graduate programs in engineering, mathematics or the physical sciences. Canada-wide, the percentage of women enrolled in full-time graduate courses in Engineering and Applied Science increased insignificantly between 1980 and 1987 (9.5% to 12.4%). The gains made in mathematics and the physical sciences were equally small (16.71% to 20.4%). Ontario just kept pace with the national gains. Between 1980 and 1987, the percentage of women enrolled in full-time, graduate courses in Engineering and Applied Science, at Ontario universities, increased from 9.82% to 11.6%. And once again, Ontario lagged behind Quebec, where female enrollments in Engineering and Applied Science increased from 8.57% to 12.4% (See Figure 14).

Ontario offers the poorest showing in mathematics and the physical sciences. In 1980-81, only 15.48% of full-time graduate students, enrolled in studies in the mathematical and physical sciences at Ontario universities, were women. Below average from the start, Ontario continues to lag behind the national norm. By 1983, more women had enrolled in graduate programs in the mathematical and physical sciences at Ontario universities. That year, the representation of females in these graduate programs just surpassed the national norm (19.75% Ontario; 18.99% Canada). By 1987, participation rates for Ontario were at the national average. But Ontario lagged behind Quebec, where, in 1980, 18.51% of full-time graduate students enrolled in the mathematical and physical sciences were female, and where by 1983 and 1987 this percentage had risen to 20.22 and 23.49% respectively (See Figure 14).

ii) Part-Time Graduates

Women represent 50% of Canadian, part-time, graduate students; they are 48% of the 11,813 part-time students enrolled in Ontario universities. This average, as in the case of undergraduate study and full-time graduate study, masks significant differences. In Ontario, women represent 67% of part-time graduate students in education; 54% of part-time graduate students in the humanities; and 42% of those in the social sciences. Women have made comparable gains in the biological and health sciences. Among graduates, as among undergraduates, more women enrolled in part time programs of study, in the agricultural, biological and health sciences, than in full-time programs of study. Between 1980 and 1987, the percentage of women enrolled in part-time programs in the health fields grew steadily, so that, Canada-wide, women came to represent 65% of part-time graduate students in these disciplines. (Statistics Canada, *Education in Canada;* Ontario Ministry of Colleges and Universities, *Statistical Summary).* This Canadian average marginally exceeded the provincial average, but in Ontario, as in Quebec, part-time female enrollments in the health sciences reached 60% (See Figure 14).

In the Agricultural and Biological Sciences, women accounted for much of the enrollment growth in part-time graduate study that occurred between 1980 and 1987. By 1987, women occupied 51% of the part-time graduate places in the agricultural and biological sciences, at Ontario universities. Their representation here exceeded the Canadian average, the rate reported for Quebec, and the percentage of women enrolled, in Ontario, in full-time graduate programs in these fields (See Figure 14).

Believed to increase women's participation in the educational system generally, opportunities for part-time study have had a clear impact on fields traditionally identified as "female." They appear, as well, to have influenced women's participation in the "soft sciences," but opportunities for part-time study do not seem to have significant bearing on women's enrolments in graduate programs in the "hard sciences." No significant difference existed in the percent of women enrolled in full-time vs. part-time programs in the mathematical and physical sciences. In fact, a somewhat smaller percentage of women enrolled in part-time programs of graduate study in engineering and the applied sciences than in equivalent full-time programs (See Figure 14).

F) EXPLANATIONS FOR PATTERNS OF WOMEN'S ENROLLMENTS IN POST-SECONDARY EDUCATIONAL PROGRAMS IN MMSET

The "problem" of women's underrepresentation in MMSET is multifaceted. To some extent, women's underrepresentation in MMSET is a relative problem; it is partly because women in these fields have not matched the gains made by women in other fields that we label and identify their achievements as "inferior", "inadequate" or "wanting". Still, both, institutional and attitudinal factors do impede women's entry into post-secondary programs in MMSET. These factors - which include: the quality of primary and secondary education; pedagogy and psychology; social stereotypes; the curriculum; feminism and anti-feminism; the pipeline; francophone, minority and disabled women; race, ethnicity and disability - affect both the recruitment of women into MMSET and their retention within the educational system.

i) Primary and Secondary Education

The number of women who enroll in post-secondary programmes in MMSET obviously varies directly with the number of girls who prepare for MMSET at the primary and secondary levels. Girls who have not received adequate preparation, or whom parents and teachers have discouraged from studying the sciences, are both educationally and psychologically ill-prepared to pursue these subjects at the post-secondary level. Hence, educational activists and theorists have often invoked poor primary and secondary preparation as a major cause of low levels of post-secondary female enrollment in MMSET. As noted in the section of this report devoted to primary and secondary education, the Ontario government and local school boards have spent significant amounts of thought and money in attempting to combat the problems posed by poor elementary education.

ii) Pedagogy and Psychology

The same sorts of pedagogical and psychological factors that impede girls' progress in mathematics and science at the primary and secondary levels also operate at the post secondary level. Despite dire warnings that Canada is "falling behind" in science and technology, and concerted efforts to attract students to the sciences, enrollments in some scientific disciplines have declined across Canada. This trend is most apparent in Ontario, where, over the past decade, enrollments, at all levels, in engineering, the hard sciences and technology have remained constant or fallen (Statistics Canada, *Education in Canada*; Ontario Ministry of Colleges and Universities, *Statistical Summary*).

Women are no more the sole victims of this trend than were girls in primary and secondary classrooms. Underfunding, overcrowded laboratories, the shift from an industrial to a service economy, and the lures of industrial salaries - which draw talented graduates away from academic teaching and research - have combined to diminish the attractiveness of scientific studies for all students. However, as was also the case in the schoolroom, women seem particularly prone to these adverse effects. Reports of a "chilly classroom climate," common among university women as a group, resound among female science students, who lodge complaints about an unsupportive social network, a lack of female role models, and "sexism" in subject matter (Hall, 1982; Daag and Thompson, 1988; Malone, 1988; Bem, 1990).

Psychological and cognitive factors, biological variables, and socio-economic pressures have all been invoked to explain the particularly strong impact of poor teaching on women students. Gilligan (1982) and Franklin (1990) both suggest that women and men "learn differently"; hence, they propose that women respond poorly to the decontextualized and hierarchical teaching methods employed in many science classrooms.

Some reports also indicate that female undergraduate science students, like girls in the secondary schools, receive differential treatment (Fiske, 1990). Large classes, where marking is done anonymously, eliminate some of the opportunity for university teachers to provide different sorts of evaluative feedback to male and female students. However, women undergraduates interviewed for an American study complained that they often felt "put on the spot" in small classes (Hall, 1982). Young women, who have been socialized to speak less and more softly, appear to also respond poorly to the interruptive styles of discourse employed in some small seminars. (Belencky, 1986; Briskin, 1990; Gumpertz, 1982; Coates, 1986). Women who have been socially trained to defer judgment and be intellectually cautious also fare poorly in male-dominated training programmes and apprenticeships, where they are told they lack "drive" or a "competitive edge". In such situations, stereotypic assumptions about appropriate male and female behaviours, and a tendency to equate success with traditionally male patterns of achievement, disadvantage women.

Unlike primary and secondary teachers, who "overhelped" female students or encouraged them to "learn helplessness" college and university instructors have, historically, appeared to demand more of their female students and to require them to prove their worth (Cohen and Okigwe, 1990; Hall, 1982; Daag, 1990). Such teaching practices have eroded women's self-confidence and self-esteem. They have also provoked significant numbers of competent and qualified Canadian women, who began post-secondary scientific studies, to abandon them (Nevitte et al., 1990; See also: "High Test Scores," 1984; Marsh, Smith and Barnes, 1985; Widnall, 1988).

iii) Social Stereotypes

The divergent rates at which women from different linguistic, regional and ethnic backgrounds pursue studies in MMSET suggest that social-stereotyping is a major barrier to women's entry into the scientific, medical and technological professions. Numerous studies indicate that Asian and East European women participate more fully in MMSET than their North American sisters, and even within Canada, the percentage of Asian women who study mathematics, engineering and applied science exceeds the average (See viii Race and Ethnicity). In the USSR, women and men participate equally in most areas of MMSET. Yet, Canadian men and boys, girls and women, continue to classify technical and scientific professions as "male" (Ellis and Sayer, 1986; Ellis, 1982). In cartoons, in literature and on television, scientists are still overwhelmingly portrayed as men, especially young men (Basalla, 1976).

Social stereotypes, which suggest that scientific studies are not women's studies, keep Canadian women from entering post-secondary programmes in MMSET; they also contribute to attrition from the ranks of those women who have already enrolled in post-secondary scientific courses. Pressure to prove scientific competence affects women in all disciplines (Nevitte et al., 1990) but it seems to impinge most on women in the engineering and physical sciences. Distinct minorities in these fields, women face the challenge of gaining both academic respect and the social acceptance of instructors and peers. Recent studies suggest that the contradictory tasks of confronting "sexist stereotypes" and "proving oneself one of the guys" tax the patience of female science students and contribute to their low self esteem; female science students are forced to achieve acceptance either by adopting a "traditional" female role or becoming "combative" and "aggressive". They are cast as either "real" women - with no scientific aptitude - or as proto-men (Baker, 1984; Hubbard, 1983; Keller, 1983).

The faith that the hard sciences are for "real men" has further encouraged engineering students to include anti-woman content in their traditional initiation rights. The publicity given to hazing rituals, at the University of Toronto and at Queen's, suggests that these rites make it especially difficult for women students to gain the acceptance of their peers. Professional and community groups alike agree that the initiation games negatively affect women students' professional image and self-esteem (University of Toronto Task Force, 1990). In the wake of anti-woman incidents at Queen's, Western, York, and, most notably, Montreal's Ecole Polytechnique, some social analysts have also come to fear for women students' physical safety.

Culturally prescribed standards of "femininity" can also disadvantage women in single-sex or predominantly female programmes of study. Informal estimates indicate that Asian students are well represented in MMSET programmes at the University of Toronto, Waterloo and York, and Asian-Canadian women often surpass the achievements of their Western sisters in MMSET classrooms. Nonetheless, these women often perform poorly on standardized tests. Well-trained Asian nurses, for example, have failed Canadian qualifying exams on grounds that they lack the ability to "take responsibility"; when asked how they would respond to particular crises, they too often answered that they would "call for the doctor". Having been continually taught - at home, school and hospital - to defer to authority, these women were then penalized for a response that appeared both socially and professionally appropriate.

Scientific genius is traditionally believed to be young genius. Television programmes like "The Whiz Kids" and "Doogie Howser, M.D." reinforce the cultural myth that children can run scientific rings around adults. This stereotypic equation of scientific genius with youth acts as yet another deterrent to women's participation in MMSET (Dresch and Janson, 1990; *What Produces Scientific Genius?* 1989). Ontario's student body is aging, and many of the "returning" students are "older" women. In traditional terms, these women are cast as "too old" to make a meaningful contribution to science; they are led to believe that they have already missed the boat. Hence, cultural myths reinforce women's tentativeness and discourage them from persevering - or from taking a little longer to forge through.

iv) Curriculum and Content

Many scientific and technologic programs of study require extensive pre-requisites in the mathematical and physical sciences. The lack of basic skills in these areas, or of necessary prerequisites, acts as an entry barrier to all potential MMSET students. Some young women who lack prior mathematical training, or who lack the confidence to continue in mathematics, drop out at this stage. Others, who might wish to persevere, do not because a dearth of remedial mathematics courses, or the stigma attached to these courses, discourages them from pursuing studies in MMSET.

A strict curriculum and inadequate opportunities for remedial or refresher instruction pose particular problems for "returning" or "older" women (Ontario Ministry of Colleges and Universities, *Statistical Summary)*. These women account for much of the growth of all of Ontario's institutions of post-secondary education, and they similarly account for much of the expansion of the labour force. Yet, they are the least prepared for secondary programmes in MMSET. Because of demographics and historical patterns of women's education, "older" women are unlikely to have received adequate preparation in math and physics. Those who did, are likely to find that much of what they learned is "outdated." Thus, remedial and refresher courses are essential to the recruitment and retention of "older" women into MMSET.

The content of scientific texts also contributes to the unease of female students. Problems or examples which have no bearing on women's lives or which undermine their experience, serve both to alienate women from MMSET and to weaken their performance on standardized tests (Berger, 1989: Mansnerus, 1989; Mandula, 1990). Articles and texts in the biological and health sciences continue to use male patterns as the norm. A recent survey of the North American psychological/psychiatric literature indicates that women subjects are not evenly integrated into a vast majority of studies, and that dramatic gender differences in diagnosis exist (Eichler and Reisman, 1988; Caplan, 1988). An even more startling study, conducted by Jean Hamilton, indicates that gender variables are excluded from key studies; male rates are routinely used to test drugs designed for women (Hamilton, 1988). If gender is lacking from some studies, it is all too present in others. Students in the biological and medical sciences still complain that instructors and texts employ sexist language; use scientific language to reinforce sex-role stereotypes, and display images of nude females gratuitously.

The resurgence of determinist schools of thought - which attribute intellectual differences between men and women to biological nature - has also contributed to the chill women experience in college and university classrooms. Socio-biological theories of male-female difference have become increasingly popular during the past decade. Inspired by the work of E. O. Wilson, sociobiologists believe that the different reproductive roles played by males and females shape their social and intellectual characteristics. Hence, some sociobiologic studies suggest that the physiologic and evolutionary processes that adapt women to childbearing also ensure that women have no scientific aptitude. So do the hormonal and physiological variants on these theories.

At a recent meeting of the American Association for the Advancement of Science, Camilla Benbow attributed differences in men's and women's achievement on mathematical aptitude tests to hormonal changes (Benbow, 1985). Sandra Witelson, a neuropsychologist at McMaster University, attributes gender differences in achievement to differences in brain structure. Women should stop beating their heads against the wall by trying futilely to be like men, geneticist and CBC producer Ann Mohr warns in her recent book, *Brain Sex*. Decried by eminent members of the scientific community as "flawed" and "bad" science, these theories nonetheless receive public coverage (Keegan, 1989, Kolata, 1989). They filter into both popular culture and the educational system, where they deter women's participation in MMSET.

v) Feminism and Anti-feminism

A recent generation of scientists, historians of science, and social critics has devoted considerable energy to disclosing and "correcting" the flaws in turn-of-the-century scientific theories of sex difference (Bleir, 1984; Kimball, 1982; Fausto-Sterling, 1985; Hubbard et al., 1982). Their efforts, the impact of women's studies, and the challenge of designing and conducting improved studies of gender differences has attracted women to the study of biological science. Women's studies, however, can serve as something of a double-edged sword in the area of women and science. Radical feminist critiques of science have done much to disclose the ways in which scientific objectivity was used to justify and perpetuate social injustice and to attract women critics and re-evaluators of scientific theories of sex difference.

A recent study suggests, however, that these analyses can also set women at odds with science, and it urges more co-operation between women scientists and the practitioners of other academic disciplines. The study, which surveyed female students at universities in Toronto, found continued failure of scientific texts to incorporate women's experiences, the persistent use of stereotypic or derogatory verbal and visual images of women, and the appeals to biological determinism were not acceptable to a new generation of students. But, rather than moving into scientific disciplines and attempting to correct earlier flaws, a significant percentage of these students dismissed the natural and physical sciences as "anti-woman" and "anti-feminist". They replaced earlier arguments that women could not study science with the new argument that women should not study science, because science represented part of a repressive male order. Hence, within this view, women scientists came to be cast as unnatural women, and an unfruitful tension developed in which female science students became isolated from larger communities of women students (Feldberg, 1988, 1989).

vi) The Pipeline

Until recently, many more women entered scientific courses than completed them. The "pipeline" - declining numbers of women at each educational level and women's restricted access to scarce educational resources - contributes to this attrition. Despite efforts to recruit women into the sciences, the combined forces of a chilly classroom climate and a social system that deemed it inappropriate for women to study science contributed to high drop out rates.

Over the past decade, this drop-out trend has, to some extent, reversed itself. If the percentages of women who received undergraduate degrees in MMSET is compared with the percentage of women who enrolled in community college and university courses, one finds that women often represent a significantly greater percentage of degree recipients than enrollees (Daag, 1990). Thus, more women appear to complete programs of study than do men. At the community college level, this was true for all degree programs except those in engineering technology, transportation technology, environmental and conservation technologies, primary industry technologies, and resource processing technologies. (Figures 15 and 16). Women university undergraduates seem also to capture a larger share of degrees than their enrollment in courses would predict. Whereas, in 1987, women represented 33% of full-time undergraduates enrolled in the agricultural and biological sciences, they earned nearly 50% of the degrees awarded. Women enrolled in full-time, undergraduate university programs in the biological and health-related sciences seemed well qualified to complete the work. Throughout these disciplines, the number of female degree recipients equalled or exceeded the number of women enrolled. Even in the engineering and applied sciences, women represented 11.3% or full-time students but earned over 20% of the degrees (Baigneé, 1990).

Graduate enrollments are slowly reflecting the successes of undergraduate women students. Since 1974, the percentage of women who receive master's degrees in the agricultural and biological sciences has steadily increased, so that it is now equivalent to the percentage that received bachelor's degrees. A similar trend can be observed in the health sciences, where, in 1987, women received 67.75% of the master's degrees awarded in

% WOMEN UNDERGRADUATE DIPLOMAS AND CERTIFICATES-COMMUNITY COLLEGES

	1983-4	1985-6	1987-8		
			Can.	Ont.	Quebec
ARTS	60.0	56.9	57.5	33.77	71.9
ARTS AND SCIENCE	64.6	73.0	73.25	75.3	NA
CHEMICAL TECH.	40.9	39.76	39.74	39.9	56.2
COMP. SCIE. & MATH.	47.5	38.85	35.78	37.1	39.3
ELECTRICAL & ELECTRONIC TECH.	2.2	4.8	5.0	5.76	7.0
ENGINEERING TECH.	9.0	9.25	9.6	8.6	10.0
TRANSPORTATION TECH.	2.0	16.5	8.4	4.8	11.6
HEALTH SCI. TECH:					
Hlth Related Tech	74.2	71.69	73.47		83.75
Nursing	94.69	92.6	92.43		85.0
ENVIRONMENTAL & CONSERVATION TECH.	31.43	24.1	19.6	18.2	31.6
NATURAL SCIENCE	47.16	46.8	47.6	47.0	47.36
PRIMARY INDUSTRIES	15.6	13.14	13.16	16.5	12.3
RESOURCE PROCESSING TECH.	19.2	32.27	39.37	48.88	33.33

Source: Statistics Canada

Figure 15

COMMUNITY COLLEGE DIPLOMAS AND CERTIFICATE

A. Undergraduate	1980-81			1983-4		
	Can.	Ont.	Que.	Can.	Ont.	Que.
Ag. & Bio. Sci.	22.88	66.67	0.0	35.46	63.16	20.0
Engineering	7.65	1.75	6.83	6.56	0.0	5.83
Hlth. Prof.	89.90	96.97	77.6	89.76	90.9	87.63
Math. & Phys.	39.62	43.75	40.51	34.88	31.28	47.2
B. Graduate	**1980-81**			**1983-4**		
	Can.	Ont.	Que.	Can.	Ont.	Que.
Ag. Bio. Sci.	36.36	40.0	20.0	14.29	16.67	0.9
Eng. & Ap. Sci.	6.25	33.3	0.0	13.97	28.57	45.64
Hlth. Prof.	34.98	20.0	37.97	43.68	25.53	45.64
Math. & Phys.	13.04	0.0	7.69	13.33	0.0	7.69

Source: Statistics Canada

Figure 16

Ontario. The percentage of women who receive master's degrees in engineering and the applied sciences, and in the mathematical and physical sciences, is not terribly divergent from the number awarded bachelor's degrees. Women enrolled in master's level degree programs seem also to fare better than their male classmates, for in all fields but engineering, women represented a larger percentage of degree recipients than students (OMCU, *Statistical Survey;* Statistics Canada, *Education in Canada*).

Fewer women seem now to drop out of the system between the bachelor's and master's degrees than they did ten years ago, but the same cannot be said for the Ph.D. In their recent study of the career goals of female, Canadian science students, Nevitte, Gibbins and Codding reported that "the very best female science students are more likely than their "average" performing counterparts to defect from science, and in fact, it is the top academic performing female science students who report the highest seepage rate" (Nevitte et al., 1990). This seepage, or attrition seems to affect Ph.D. enrollments particularly, perhaps because the promise of academia is no longer as attractive as that of industry. Throughout Canada, women received roughly twice as many master's degrees in the sciences as they did Ph.Ds. Sheila Widnall has reported similar statistics for the U.S. (Widnall, 1988). Ontario remained true to the trend. In all scientific fields, women received fewer than 30% of the Ph.D degrees awarded (See Figure 17).

PERCENT DEGREES AWARDED TO WOMEN, CANADA, ONTARIO, QUEBEC

GRADUATE DEGREES

I. MASTER'S	1974	1979	1980			1983			1987		
	Can.	Can.	Can.	Ont.	Que.	Can.	Ont.	Que.	Can.	Ont.	Que.
Agri. and Bio. Sci.	21.39	31.25	34.0	52.9	34.37	40.06	42.6	42.74	45.57	46.6	47.8
Engineering and App. Sci.	2.48	3.55	7.03	7.7	4.15	8.72	8.7	10.5	11.0	10.8	11.5
Hlth. Prof.	44.27	60.61	65.67	61.06	74.85	59.58	59.05	58.85	65.36	67.75	63.6
Math. and Phys. Sci.	15.15	15.35	17.47	17.6	17.35	20.38	31.22	17.9	23.35	23.0	24.3
II. Ph.D.											
Agri. and Bio. Sci.	10.93	11.4	23.33	23.9	25.9	23.48	23.95	13.0	28.0	28.0	32.7
Engineering and App. Sci.	1.33	0.99	3.14	1.9	4.76	4.54	6.6	3.8	5.0	5.0	9.0
Hlth. Profs.	13.73	25.71	32.85	25.5	55.0	31.61	40.54	28.75	30.0	27.0	31.9
Math and Phys. Sci.	5.9	9.4	8.38	7.0	12.28	12.94	12.0	14.75	12.9	12.0	12.0

Figure 17 Source: Statistics Canada

Psychological, social and economic factors account for the attrition of women from higher degrees in MMSET. As the data presented above indicated, women still represent less than a third of all Ph. D. students in the sciences. They lack the networks and support systems needed to sustain students through what is often a long and lonely process (Hall, 1982, 1983, 1984; Daag, 1990). In disciplines that require long hours of labwork, the feeling of isolation can become debilitating. Moreover, the conflicting demands of "home and work" impinge particularly on women scientists, who depend on cumbersome and complicated equipment to perform their studies. Unlike their counterparts in the humanities and social sciences, these women cannot routinely bring their work home. Instead, they must spend long hours in the laboratory. Hence, for women scientists, the challenge of balancing family and career remains real (Feldman, 1989).

The challenges of balancing family and career appear to punish female science students doubly. Despite evidence that motherhood and science do mix, it is often presumed that they do not, and that women will become unproductive as they follow the "mommy track" (Stark, 1987). Hence, women graduate students must show that they are both more committed and better than their male peers. Like female undergraduates, women graduate students often complain that they must continually prove themselves. They feel that they must achieve more than their male peers and prove that women will not drop out once the going gets too tough.

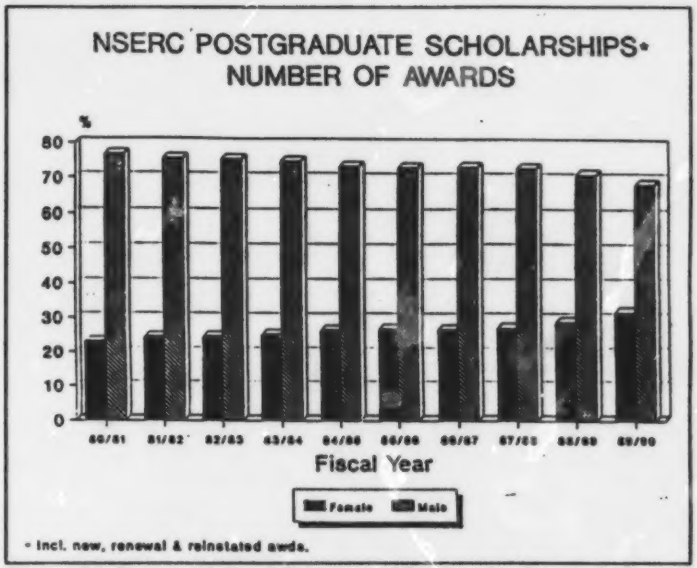


Figure 18 Source: National Science and Engineering Research Council

Greater commitment to achievement does not always translate into tangible gains. Like female undergraduates, women graduate students pay a psychological price for their dedication. Self-esteem is low in this population, and numerous studies indicate that the women's personal assessments of their own abilities do not adequately reflect achievements (Conroy, 1989). Moreover, though professors often have higher expectations of women graduate students they do not provide them with more extensive advising. Some studies indicate that women graduate students receive less advising than their male peers (Hall, 1983; Daag, 1990).

When it comes to evaluations, which can be tangibly measured through the acquisition of fellowships and jobs, women fare less well than men. The number of postgraduate National Science and Engineering Research Council (NSERC) scholarships awarded to women has increased somewhat over the past decade, but women still represent less than 30% of recipients, and for every grant given to women, men receive almost three (Figure 18).

vii) Francophone, Minority and Disabled Women

Francophone, minority, and disabled women participate in all programs of post-secondary education offered in Ontario. Whether these women participate fully in courses of technical and scientific training is not easy to glean from published statistics, for few sources break down data by linguistic identity, race, or disability.

viii) Race and Ethnicity

Canada-wide, women's achievements in MMSET differ significantly from men's. These differences persist in all ethnic groups. Despite the superior achievements of Asian women, in the areas of engineering, applied sciences and technologies, mathematics and physical sciences, these women participate less fully in MMSET than comparable populations of men. Across ethnic groups, surprisingly few differences in women's participation exist. When taken as a proportion of the educated population, Aboriginal, Asian, Black and Francophone women appear to attain similar levels of participation as their British-origin sisters (Figure 19).

CANADA-WIDE POPULATION, PERCENT 15 YEARS AND OVER WITH POST SECONDARY QUALIFICATIONS IN MMSET, BY GENDER AND ETHNIC ORIGIN

	Asian		British		French		Black		Aboriginal	
	F	M	F	M	F	M	F	M	F	M
Agriculture and Biological Sciences and Technologies	6	5	4	5	5	5	4	5	6	5
Engineering and Applied Sciences	2	18	.3	6	.3	4	.2	5	.3	2
Engineering and Applied Sciences and Technological Trades	5	25	3	42	3	42	6	42	6	54
Health Professions	21	8	20	4	18	4	4	27	17	3
Mathematical and Physical Sciences	6	10	2	4	2	4	2	4	1	2

Source: Statistics Canada, *Dimensions*, 1989

Figure 19

Thus, ethnicity and race are not insurmountable barriers to educational achievement in MMSET; cultural stereotypes about "appropriate" female roles may be far more influential. However, by treating all forms of post-secondary education alike, Figure 19 hides real differences in access to resources. Canada-wide, Aboriginal women have limited access to post-secondary education. 37% of these women have less than grade 9 schooling, and only 17% have trade or other non-university post-secondary training. Only 1.3% of aboriginal women graduated from university. Thus, the 17% of Aboriginal women who have qualifications in the health sciences received very different schooling than the comparative 20% of British women (Statistics Canada, *Dimensions*; *Women in Canada*, 1990).

Ontario probably does not differ from Canada in this regard. The post-secondary educational institutions that offer training for the trades and professions are primarily located in southern, urban centres. When enrollments in MMSET at Ontario universities, are broken down by region and language of instruction, real differences in accessibility and use emerge. For example, of the 1400 undergraduate places in engineering, offered to women at Ontario universities in 1987, only 19 catered to Northern populations; only 109 catered to Francophones. Similarly, few places in mathematics, the physical sciences, or the agricultural and biological sciences, are easily accessible to Francophone or northern populations. The number of places in mathematics and the physical sciences increased somewhat at the Ontario's French language universities during the 1980s, but the number of degrees granted, in the agricultural and biological sciences, at the University of Ottawa and Laurentian, actually declined slightly (from 155 to 147 and from 17 to 16 accordingly) (Ontario Ministry of Colleges and Universities, *Statistical Summary*).

Similarly, enrollments in technology, at the Colleges of Applied Arts and Technology that educate the greatest percentage of francophone students, declined sharply. MA and Ph.D. degrees are even less accessible to Francophone and northern women, for few university programs exist to meet their needs (Ontario Ministry of Colleges and Universities, *Summary Statistics*, 1981-87). Unless better provisions are made for post-secondary education, efforts to integrate francophone girls into elementary and secondary math and science classes will be for naught.

Disabled women are particularly disadvantaged in MMSET classes. Instruction in these classes tends to rely heavily on laboratory participation. Though many Ontario colleges and universities have recently attempted to make their campuses wheelchair accessible, few have extended their efforts into labs. Hence, for many disabled women, lab benches and equipment remain, literally, beyond reach.

G) CONCLUSION: DIRECTIONS FOR CHANGE

The "problem" of women in post secondary science education begins with the patterns of primary and secondary education that discourage girls from pursuing advanced studies in MMSET. Recruitment remains a significant problem. Recent statistics indicate that, both in Canada and the United States, fewer and fewer students of either sex are choosing to study science. If industry and government believe that Canada needs more scientists, they must actively encourage qualified high school students to continue. American colleges and universities have successfully earmarked fellowships for women and used them to recruit girls into MMSET (McMillen, 1987; 1988). Ontario's universities appear reluctant to accept new, "single-sex" awards, which they fear are discriminatory. Nonetheless, scholarships designed to attract women students into the sciences can and have been implemented. The recent program of Canada scholarships, sponsored by the Federal government, appears to be particularly successful. Fifty percent of the scholarships are awarded to female students. Hence, these scholarships attract more women into MMSET and indirectly alter the gender balance in these fields.

American colleges and several universities in Ontario have implemented non-monetary recruitment strategies, such as special pre-semester programmes designed to attract women to MMSET. In Ontario, York University and the University of Guelph have hosted pre-recruitment programs, and the University of Toronto recently implemented one (*CAUT Bulletin*, November 1990). Other colleges and universities, especially those serving Francophone, minority and disadvantaged populations, might be encouraged to develop similarly specialized recruitment programs.

Scholarships and pre-semester programs attract girls and women to MMSET but do little to keep them there. **Retention** remains a key problem at the undergraduate level and especially at the graduate level. Fewer women enter Ph.D programs in the sciences; proportionately fewer women than men also complete these programs. Efforts to recruit more women into the sciences consequently must be coupled with measures that will keep them there. For women graduate students in particular, networks that provide a forum for airing intellectual and personal problems and also concrete assistance in matters that range from childcare to interviewing skills are critical. The Bunting Institute at Harvard University has successfully implemented workshops of this kind. **Mentoring programs**, which pair potential science students with women who have successfully followed a chosen education path; **career internships**, which allow students to experiment with different types of employment; and **support networks**, in which students can share both academic and personal problems, have proven useful at both American and Canadian universities (Radcliffe College Student Internship Program; York Student Advising Network and Bethune College Science and Society Program; See also Hall, 1983).

Another change, which is more difficult to implement, involves a restructuring of science itself. **Curricular and pedagogical changes** can help to promote this transformation. The experience of female science students in single-sex universities, such as the American Bryn Mawr College, suggests that single-sex classes increase women's participation in MMSET at the post-secondary level. So do interdisciplinary courses; lectures that focus on the relevance of science; and less competitive marking schemes. The introduction of science, technology and society programs and courses that focus on the social and humanistic content of science can contribute to this process.

Canadian universities have implemented two kinds of innovative programs that might spearhead curricular reform. Bethune College, at York University, is in the process of developing a science and society focus. Representatives of the College recently approached the Canadian Association of Women in Science about ways in which the two institutions might co-operate to bring in gender studies to the Science and Society theme. The college hopes to use interdisciplinary seminars to both recruit women into MMSET and to prevent attrition by addressing issues that cause women to leave. (Personal communication, Judy Libman and Dawn Beazley, September 1990). Mount Saint Vincent University developed a proposal for, and is now seeking funding for, a women in engineering program in which students will take the first two years in single-sex all-women classrooms. (Personal communication, Eleanor Bradley, Industry, Science and Technology Canada).

But we must move beyond interventions. Reflecting on the limited impact of a decade of activism, Marsh Hanen recently charged academics to consider why it is that we want more women in sciences (Hanen, 1990). We believe this question should be addressed two ways: First, the theories used to explore the relations between women and science need to be further examined; second, the political and economic bases of calls for women's increased participation in science need to be understood.

As calls for new, more humanistic, more critical science proliferate, one school of feminist scholarship has targeted women as the standard bearers of change. Numerous proponents of a "feminist" science charge women with the responsibility of creating a less hierarchical and more contextual science. This new vision places a tremendous burden on the shoulders of women students. Already minorities, they are additionally charged with the responsibility of being mavericks. One end product of the tension is a heightened dissatisfaction on the part of feminists with women scientists, and, on the part, of women scientists with feminism (Feldberg, 1989).

Therefore, to achieve the dual goals of reforming science and attracting more women into science, it is important to facilitate dialogue between women scientists and the women's movement. We call for greater interchange between scientists and humanists, professional and grassroots women's groups and especially between women in science and women's studies.

We further believe that the problem of ensuring greater female participation in MMSET programs offered at Ontario's community colleges and universities is most closely tied to problems of the workforce. It is in the workforce that the greatest initiatives must be taken. We devote the remainder of this report to a preliminary analysis of this interrelationship.

III. WOMEN IN THE SCIENCE, MATH AND TECHNOLOGY WORKPLACE

> . . . perhaps most important, we should give some thought to why we want women in science and technology - something we rarely do.
>
> (Hanen, 1990)

> There exists now a substantial body of documentation showing how teaching, research, and practice in most areas of science and technology follow essentially male patterns by being hierarchical, authoritarian, competitive and exclusive.
>
> (Franklin, 1990)

> The old rules do not work in the new reality. It's time for a different game plan that brings new players in off the bench.
>
> (Malcolm, 1990)

Unlike literature and the arts, science and technology rarely serve as hobbies. Our culture views these disciplines as practical, marketable and applicable. This image is reinforced by industries and government, who promote science as an essential pre-requisite to Canadian economic growth. Hence, women usually seek educational qualifications in MMSET to procure work. Yet, despite promises that scientifically and technically trained Canadians are uniquely qualified for the marketplace, women have not fared well in the MMSET workforce. As is the case for post-secondary education, the gains made have been small and uneven.

Analyses of women's work in MMSET have tended to focus on the elite professions where women are severely underrepresented. During the past 15 years, Canadian women have made some gains in the professional sectors of the MMSET workforce. They have increased their numbers in fields where women traditionally represented a minority, and they have infiltrated occupations, like dentistry and veterinary medicine, in which no women previously worked. Still, increases in participation are not uniform. Segregation by field, ghettoization, and stratification persists.

In some fields, such as biology and bio-medicine, women now represent a majority of graduates. As these women enter the workforce, they have become a majority of workers in the health care sector. But despite their increased numbers, women remain disproportionately concentrated in the lower-status, less-well paying jobs. Even as women have come to represent almost 50% of Ontario's medical graduates, they have not become an equal force in every specialty. Women physicians continue to work in a few select areas (Royal College of Physicians and Surgeons, 1989).

The same is true within academia. In 1987, women represented 17.6% of the full-time faculty employed at Canadian universities; however, despite women's gains in medicine, only

12% of Ontario's medical faculty were women (Royal Society of Canada, *Plan*, 1989). The representation of women among science faculty was still worse: only 13.5% of full-time professors in animal biology, 9.8% of professors in microbiology/biochemistry, and 12.6% of professors in botany were female, and the percentage of full-time female faculty dropped to 7.5% in chemistry, 6.6% in math, 4.5% in earth science, 2.9% in applied science, and 2.2% in physics. Mathematics, engineering and the physical sciences remain male bastions; women continue to represent a small fraction of Ontario's practising engineers (Royal Society, *Plan*, 1989).

Women trained in MMSET also work, often in great numbers, in the trades - as technicians and technologists, and in semi-professions like nursing and computer programming. Whether gains have occurred in these sectors is less apparent. In the engineering and applied sciences, women have made greater gains in the better-paid white collar and professional sector than in the blue collar trades and highly technical jobs (*Women in Canada*, 1990; Connely and MacDonald, 1990). At Ontario Hydro, for example, the proportion of women engineers greatly exceeds the proportion of women in the trades (Ontario Hydro, 1986). Elsewhere - as in the health care and clerical sectors - women have begun to lose traditional positions of advantage. Women nurses, technologists, technicians and aides have traditionally been a majority, but as technology redefines the content and status of these positions, men have begun to establish a toehold.

Our assessment of these uneven gains rests on several assumptions. First, we view women's work in MMSET as part of a broader picture of women's work and try to focus on the jobs that women actually do. Others have demonstrated that in both waged and unwaged work, the jobs in which women predominate are often undervalued (Armstrong and Armstrong, 1978; Stratham et al., 1988). This is also the case in MMSET. Nursing and the technical and technological fields in which women abound are ascribed low status, and they are overlooked by analysts who concentrate on the elite scientific professions in which women are underrepresented. We attempt to reintegrate the "low-status," "female-dominated fields" back into our analysis of women's participation in the MMSET workforce. We suggest, as well, that women employed in MMSET share a set of problems with all working women.

We also suggest, however, that the women who work in MMSET face another subset of problems. Some of these they share with other women who work in "non-traditional" fields, but other stresses are unique. These include lack of mentoring, the scientific "double day, double bind," peculiar difficulties of re-entry, and the problem of "expectations".

In what follows, we briefly survey the problems that women employed in MMSET share with other working women. We then provide an overview of the problems faced by women in MMSET that are similar to those faced by other women who work in non-traditional areas. Finally, we assess some of the pressures unique to women in MMSET. Here, we attempt to distinguish the problems of women in the trades from those of professional women.

A) BACKGROUND: WOMEN AND WORK

The women who work in MMSET are, for the most part, a subset of the class of working women, and they share many problems with other women who work. They, like other working women, have difficulty receiving training, finding childcare, balancing home and career. They move through the ranks more slowly, are paid less and are harassed more. A full overview of these problems is beyond the scope of this report, for it is part of equally voluminous bodies of literature on women and work and on women and science. However, four problems do deserve brief analysis. These include entry into the workforce, pay inequity, job segregation and job stratification. By the latter term, we mean both that women are confined to certain occupations or levels of job, and that they are frequently placed in subordinate, lower status positions.

i) The Problem of Numbers

The entry of women into scientific and technical careers reflects broader patterns of women's entry into the workforce. The problem of women's representation in MMSET is, to some extent, relative to women's employment in other areas. To a great extent, women are entering MMSET in fewer numbers and at a slower rate. Women have always worked inside the home, and single women and working class women have long been employed outside the home. Still, two major shifts in patterns of women's employment have occurred since the second world war. These are in the percentage of women who are employed outside of the home on a permanent basis, and in the proportion of married women, "middle-class" women, and educated women who form a permanent part of this workforce.

Fewer of the new working women have followed careers in MMSET, for reasons that tie back to problems in post-secondary education. Women enter the workforce for the same reason as men; the changing structure of the North American family, shifting expectations of women's careers, and increasing costs of living in Canadian cities all contribute to women's entry into the marketplace.

However, patterns of women's employment continue to correlate most closely with patterns of women's education (Connely and Macdonald, 1990; Armstrong and Armstrong, 1983). Throughout Canada, as women have come to occupy more of the places in community colleges and universities, they have also come to play an increasingly pivotal role in the labour force. In Ontario, the participation of women doubled, between 1967 and 1984, to 57%. There are now over 2,000,0000 Ontario women who work outside the home, three times the number employed in 1961 (*Training Women in the Workplace*, 1987; Connely and Macdonald, 1990).

Because of this increased participation, women have been the fastest growing sector of the work force, accounting for seven of every ten people who entered the Canadian labour market between 1976 and 1985. These trends are expected to continue through the next decade, and it is expected that the entry of women into the workforce will account for two-thirds of total labour force growth. By the year 2000, their share of the total workforce will be 48% (Connely and Macdonald, 1990). Yet, women in MMSET are not participating equally in this growth in the labour force. Even as more and more women receive degrees in scientific and technical fields, the numbers of women employed in MMSET remains relatively small.

Workplace problems such as wages, job segregation, and stratification, contribute to low levels of women's entry into the MMSET professions and trades. They also contribute to attrition. As many analysts of women and work have noted, equal numbers unfortunately does not mean equality. Three kinds of occupational inequality predominate.

While the earnings gap between men and women has narrowed in recent years, women full-time workers still earn, on average, only $.65 for every dollar that men earn, (Connely and MacDonald, 1990) although women workers, on average, are better educated. Research indicates that much of this gap results from "occupational segregation", the fact that women remain concentrated in narrow, traditionally defined, "women's job ghettos". Approximately 75% of working women are in the clerical sector alone. Only about 1% are employed in high skill, blue collar occupations and 1.3% in the natural sciences. In many cases such segregation (as a percentage of total employment in a given sector) has remained constant or even increased in recent years (*Training Women in the Workplace*, 1987; Connely and Macdonald, 1990). Occupational segregation reduces the average salary received by women because female-dominated job categories or sub-categories tend to be less well paid than male-dominated categories. Outside the home as within, women often perform "invisible work" (Armstrong and Armstrong, 1978; Daniels, 1987). Even after women have combated job segregation by entering the better paid, traditionally male professions, pay inequities persist because these professions become stratified. In other words, within the professions, women are clustered in ranks and in jobs that bring less prestige and lower salaries.

Little of this information is "new". Sociological analyses and government reports, such as the 1970 Royal Commission on the Status of Women, have long acknowledged the problems of occupational segregation, pay inequity, and stratification. Recent studies report that women often find the workplace as chilly as the classroom. Interviews with working women indicate that while on the job, they are unheard, unappreciated and sexually harassed. Obviously, there are a host of other issues, such as childcare, which are equally important, but because they relate more particularly to the employment status of all women, seemed beyond the scope of this report.

Just as women in MMSET are victims to the forces that impede all women's employment, so are they the beneficiaries of recent gains. If progress towards equality has been slow during the past twenty years, there are some grounds for optimism about the 1990s. Affirmative action policies adopted by universities, government and industry acknowledge the low levels of women in some sectors of the workforce. Such policies attempt to redress inequity. These programs have their limitations, and some set low targets. For example, even the most progressive universities limit their affirmative action efforts to sectors in which women represent less than 30% of employees (Ontario Confederation of University Faculty Associations [OCUFA], 1990). Still, these programs, do have an impact.

New federal and provincial legislation on pay equity and contract compliance similarly has an impact. Recognition that women start at lower salaries than men and progress through the ranks more slowly has prompted several Ontario universities to undertake investigations of salary anomalies which address existing inequities and ensure that women now enter the workforce at salaries commensurate with those paid their male colleagues. The private sector has adopted similar initiatives. Some newly-graduated women engineers already receive more job offers, at higher starting salaries, than their male classmates.

There is some evidence that, in the future, the recruitment, training and promotion of women will increasingly be driven by necessity rather than by equity considerations. The highly skilled male workforce is aging, (the average age of a bricklayer in Ontario is 57 years old - *Vision 2000*, 1988, 1990) and some projections indicate that, in the next decade, retirements will produce labour shortages in many skilled trades. Immigration of highly skilled workers from other countries is also declining, and the population is not growing rapidly enough for young people to replace them. This is especially true in the building trades, mechanics and electronics. Hence, the *Vision 2000* (1988, 1990) report predicts that labour shortages will become more and more the norm.

The impact of a "greying" and shrinking workforce is likely to be great in the areas of MMSET. *Vision 2000* (1988, 1990) like other reports, notes that technical innovation is essential to ensure economic competitiveness. Yet, Canada now has the lowest number of engineers and scientists, per capita, of any industrialized OECD, and the number of young white males choosing MMSET careers is actually declining. *Vision 2000* (1988) notes that "women are underrepresented in many of the occupations experiencing critical labour shortages." Ontario is already responding to an impending crisis by mounting efforts to attract women to the trades and other non-traditional occupations.

Here, however, it is important to note the disjunction between rhetoric and reality. Many reports note that women "tend to" work in the clerical, sales and the service sectors, and they are underrepresented in the MMSET marketplace. In 1988, 84% of working women were employed in the service industries; nursing was the only MMSET occupation listed among the top ten occupations of Canadian women (*Women in Canada*, 1990).

Yet, sales and services have been fastest growing sectors of the Canadian economy during the past decade. Industry and government often lament that Canadians are scientifically illiterate. ("Some Canadians still trailing Copernicus . . ." *Globe and Mail*, March 1, 1990). They issue frequent appeals for better scientific and technical education on the grounds that there is an economic need "for students to learn new technologies and adapt quickly to new technology" (*Vision 2000*, 1990). But few real jobs exist in MMSET, and there is little indication that more will exist in the near future. Neither government nor industry matches rhetoric with action. Canada has an appallingly low level of funding for scientific research and development (R&D). UNESCO recommends that developed nations devote 2.5% of their GNP to R&D, and it advocates that developing nations spend 1.5% of their GNP on R&D. Canada currently spends 1.32% of its GNP on R&D. Not only is this sum less than that advocated for developing nations, but it has declined by .6% since 1984 (*University of Waterloo Gazette*, Oct. 31, 1990).

ii) Pay Inequity, Job Segregation and Stratification

The pressures that women experience in the MMSET workplace are similar in kind to those borne by other working women. They, like women who work elsewhere, are often underpaid. In virtually every MMSET field women's salaries tend to be approximately 10% lower than men's (Connely and MacDonald, 1990). As is the case among women workers generally, these wage differentials can, to a great extent, be attributed to job segregation and to stratification. Women comprise the vast majority of employees in the health care sector, for example, but they traditionally work as nurses, aides and technicians. Even as the composition of the medical profession has moved toward equity, women physicians earn less than men. In 1988, there were 5,895 male and 5,235 female physicians and surgeons in Ontario. The males earned, on average, $90,562; the females earned, on average, $57,126 (Figure 20; Royal College of Physicians and Surgeons, 1989).

Some of this salary variation can be attributed to differences in the number of hours worked, but it is also a result of the fields in which women physicians work. Women remain concentrated in the less lucrative subspecialties. Though women represent almost 50% of Canada's medical graduates, they represent a small fraction of cardiologists, orthopedic surgeons, or obstetrician/gynecologists. The imbalance between male and female practitioners in these disciplines can be attributed, in part, to the relatively recent entry of large numbers of women into medicine. Specialties which demand long periods of internship and training tend to be dominated by older age-cohorts, which are still dominated by men. Some of the inequity disappears when specialties are broken down by age. A small percentage of all specialists, women sometimes represent a large percentage of specialists in the younger age-groups. Among obstetrician/gynecologists, for example, women represent 5% of specialists in the age group 55-64; 10% of those aged 45-54, and 25% of those under 45. However, the gains are not uniform across all subspecialties. In cardiology, 50% of specialists in the 55-64 age bracket were female, compared to 1% in the age group 45-54, and 17% of those under 45; similarly in neurosurgery, women represent 1.2% of those specialists aged 45-54 and 4.5% of those under 45. Women are similarly underrepresented in the newer subspecialties: 16% of radiation oncologists; and 11.8% of specialists in nuclear medicine (Royal College of Physicians and Surgeons, 1989).

Academia is similarly stratified. Across Canada, 90% of women are concentrated in the lowest professorial ranks. Hiring has not kept pace with the increasing number of women graduates. A recent American study reported that "more women are earning doctorates in mathematics, but few are being hired by top universities" (Turner, 1989). Much the same holds true in Canada. Women are even a minority in the disciplines that graduate the most women. For example, women represent less than 15% of Ontario's professoriate in the biological and medical sciences. At the community colleges, where women represent the vast majority of students, female faculty are also underrepresented (Royal Society, 1989).

The National Science and Engineering Research Council (NSERC) has recently implemented a fellowship program designed to help rectify the problems of imbalance that prevail in academia. The NSERC Women's Faculty Awards are similar to the Canada

Figure 20

CANADIANS AND THEIR OCCUPATIONS—ONTARIO (1988)

Occupation	MEN	Income	WOMEN	Income
Administraors in Med. & Hlth. Ave. emp. income	2,085	$46,630	3,960	$33,367
Chemists	4,115	$39,257	1,145	$24,981
Geologists	1,330	$48,978	145	$34,783
Physical Science Technologist & Technicians	5,380	$31,893	1950	$23,691
Agriculture Sts.	2,195	$36,272	510	$25,340
Biologists	1,580	$38,371	985	$27,988
Life Sci. Techs.	1,685	$28,165	1,320	$22,108
Civil Engineers	10,975	$42,448	600	$31,816
Elect. Engineers	14,235	$41,495	845	$31,900
Industrial Engineers	8,350	$38,017	815	$27,645
Mechanical Engineers	12,175	$40,901	390	$31,372
Engineer Technologist - Technicians	17,940	$32,143	2,665	$22,195
Mathematicians & Statisticians	2,000	$41,206	1,165	$29,425
Systems Analysts & Computer Programmers	35,490	$35,198	15,130	$27,783
Physicians & Surgeons	5,895	$90,562	5,235	$57,126
Dentists	4,370	$37,346	715	$46,777
Veterinarians	1,030	$40,429	570	$27,414
Pharmacists	3,060	$39,735	3140	$30,115
Radiological Technicians & Technologists	515	$31,373	2,945	$26,690
Medical Technicians & Technologists	3,645	$31,827	11,590	$25,326
Dental Technicians & Technologists	1,105	$26,401	645	$17,862
Machinists	23,340	$26,874	1,365	$18,180
Indust., Farm Equip.	3,290	$25,768	395	$16,668
Precision Equipment	715	$25,013	810	$17,297
Electrical	12,665	$29,351	215	$19,835
Electronic	6,140	$29,446	870	$22,900
Mechanics, Motor Vehicle	55,735	$22,534	915	$17,761
Mechanics, Aircraft	2,910	--	--	--

Source: Statistics Canada, *Dimensions*, 1989

Research Fellowships (CRF) offered by the Social Sciences and Humanities Research Council. They are designed to pave the way for academic appointments. Unlike the CRFs, however, the NSERC awards are expressly designed to "encourage universities to hire more women to academic positions". The awards can be used to establish both tenure-track and tenured positions; hence, they tackle both problems of recruitment and problems of retention.

Women are least represented at the higher ranks. Across the professions and trades, women not only earn less, but they move more slowly through the ranks and achieve less advanced positions. Women represent barely 2% of the full-professors in scientific fields. Inequity persists even in the younger cohorts. For example, 77% of female engineers aged 25-39 are in non-supervisory positions while 60% of their male colleagues are managers. Likewise, male nurses, by far a minority in the profession, rise more quickly, and in greater numbers, to supervisory positions (Armstrong, 1988).

Women who work in MMSET, like women in other trades and professions, complain of being unheard, unappreciated and sexually harassed. One survey of women engineers in Alberta reported that one third of the sample had experienced sexual harassment. (Dayton, 1990) As numerous reports issued by the Canadian Association of University Teachers, OCUFA, the Ontario Nursing Association, and women's groups regularly note, women in nursing and academe similarly complain of harassment.

Thus, because women who work in MMSET share so much with other women who work, we believe that no attempt to make substantial changes in the proportion of women in the MMSET workplace can succeed without also focusing on the workplace itself (Quinta Consulting, 1987). Necessary changes include:

- structural barriers within the organization, such as policies, benefits, communications or expectations which might have a differential impact on men and women. For example, employment situations in which geographical mobility is a requirement of promotion.
- attitudes of co-workers, supervisors, managers and support staff.
- practices and standards within a given field. The question of practices and standards has recently become key to discussions of affirmative action, for it is feared that programs which seek to increase the participation of women without simultaneously redefining standards of excellence and achievement to include patterns of female career development will have limited impact. For example, the presumption that mathematicians and scientists "peak young" disadvantages women who re-enter the work force after bearing their children.
- pay equity and affirmative action. Existing pay equity provisions will result in much needed salary adjustments, but women in some female dominated-workplaces, such as nurses in hospitals, need further accommodation. (Armstrong, 1988). Women in male-dominated academic and professional settings also need further consideration.

B) WOMEN IN MMSET AND THE PROBLEMS OF NON-TRADITIONAL WORK

The barriers that keep women from the MMSET workplace are those which affect all working women, but there is reason to suspect that the net impact is greater for women in non-traditional workplaces (as in classrooms) where women's toeholds are more tenuous, and where they are constantly buffeted by forces pushing them back toward traditional fields. There are also a variety of stresses unique to fields in which women are underrepresented.

An exhaustive review of all the issues related to women and the "non-traditional" work force is beyond the scope of this report. We highlight here some of the major issues and trends which have particular relevance to MMSET careers and profile a few intervention programs.

i) Tokenism

Tokenism is taxing. Women in non-traditional jobs are often minorities, and they face the added burden of being "tokens". In a recent study of Ontario's women engineers, two thirds of the respondents agreed with the statement that a sole woman on an engineering team experiences additional stresses due to her visibility (Stephen Jack, Association of Professional Engineers of Ontario, personal communication, 1990). A report from Ontario Hydro reports that women in trades and technical occupations experienced pressures greater to those experienced by most male counterparts to gain acceptance and credibility in their work groups (Ontario Hydro, 1986). Within universities, the requirement that committees regularly have at least one woman representative places added burdens of time and responsibility on female faculty (Briskin, 1990a). Across the disciplines, token women find themselves being constantly pushed back into more "traditional" roles. For example, the sole woman at a meeting is typically asked to take notes, and she may find herself quickly cast as the secretary.

ii) Training

A number of recent studies suggest that although women enrol in more continuing education courses, on their own time, they receive less than their share of job-related, employer-sponsored training (Wismer, 1988). These studies focused primarily on the needs of women in industry and suggested that in spite of special efforts made to retrain women for new, emerging occupations, only 33.5% of training recipients in the first year of the Ontario Skills program, the employer incentive program of Ontario's Training Strategy, were women (Ontario Ministry of Skills Development, 1987). Not only were women quantitatively underrepresented, but employer surveys indicated that, as compared to male workers, the quality of training was also inferior. Women were:

- less likely to receive longer-term training;
- less likely to be offered training in areas of most importance to the employer; and
- less likely to be trained in the skills required for new and emerging occupations or for managerial or supervisory positions.

The difference in opportunities for training serve to perpetuate the status quo. Women in traditional job ghettos are unlikely to receive employer-sponsored training that would help them move either "upwards", into management, or "outwards" into emerging non-traditional occupations.

Operative within industry, these inadequate forms of skills training also impede the career development of women employed in the health care sector. Nurses, aides, technicians and technologists find that technology continually redefines the content of their work as does the redefinition of skill as technical expertise. "Lack" of technical skill confines women, in these professions, to particular, low status jobs and impedes their career progress (Armstrong, 1988; McPherson, 1989; Yalnizyan, 1986).

There are no simple or single solutions to these deficiencies. A 1987 report by the Ontario Ministry of Skills Development concludes that what is required is a "broad approach", which seeks to enhance both the supply of women and the demand for women in all types of skills training. Specific recommendations include:

- assistance in placing qualified or interested female trainees with employers willing to train women in the skilled trades;
- promotion of the availability of employer-sponsored training directly to women; and
- adjustment of client eligibility criteria under the Canadian Jobs Strategy to increase access by women.

However, while the skills development report acknowledges the need for better training, it also identifies the need for more general improvements in women's work life, among these the provision of adequate childcare and childcare allowances.

iii) Career Interruption and Perceptions of Scientific Genius

The career path of professional women, like that of women in the technologic trades, can resemble a roller coaster more than a straightaway. Canadian women represent a significant percentage of part-time students, and as such, they have frequently delayed education and career for childbearing. Women within this category who wish to pursue scientific careers are triply disadvantaged.

The rapid pace of technologic change and increase of scientific knowledge ensure that anyone who takes time out will quickly fall behind. The woman who wishes to keep abreast of her field cannot afford to take time away to bear children. Cultural images of the scientist as young, single minded and directed (Mead, 1948, 1957; Basalla, 1978) issue further challenges to women. The psychological stresses of tokenism and long working hours create one set of health hazards for women, who during their reproductive years might well wish to work part time. The chemicals and radioactive materials frequently used in laboratories create another health hazard for women of reproductive age, who might be well advised to take some time away. Yet, expressions of interest in "non-scientific" matters, the need or desire to delay one's career, or expressions of concern about occupational hazards are by definition a denial of scientific culture, and those who espouse them become, by definition, second rate.

C) INTERVENTIONS

Barriers of tokenism, training, mentoring and re-entry all affect women's entry into the MMSET workplace, and as study after study reports that women "choose" not to work in scientific and technologic areas, a variety of programs have been implemented to recruit women into these areas of work. These include:

i) Apprenticeships

Apprenticeships are one type of on-the-job training in which women have been particularly underrepresented, even though the jobs for which they prepare offer relatively high-pay and, often, good future growth opportunities. Overall in Ontario, women comprise only 5% of apprenticeship trainees and these are primarily concentrated in the trades of hairstylist and cook (*Women in Canada*, 1990; Connely and MacDonald, 1990).

To combat the projected crisis in skilled workers, Ontario is making several efforts to increase the number of women in the trades and other non-traditional occupations. These include: awareness campaigns, such as a set of posters produced by the Women's Directorate which present women working in a variety of non-traditional jobs including iron worker, carpenter and machinist; a handbook for counsellors of female apprentices (Ontario Ministry of Skills Development, 1989); and the new Women's Access to Apprenticeships Demonstration Projects that are jointly funded by the Ministry of Skills Development and the Ontario Women's Directorate. It is too early to judge the success of these initiatives, though they are clearly steps in the right direction.

ii) Mentoring

Robert Merton's classic sociologic study (1968) indicates that students of Nobel Laureates are more likely to themselves receive prizes, awards and plum jobs, in large measure because networks of association increase opportunities for these students. Similar sorts of networks operate in the trades. Women are often excluded from these networks, for studies indicate that the senior members of a field are more apt to mentor individuals of the same sex. Because there are few senior women in any MMSET profession or trade, women are unable to form their own networks.

American studies have found that women are ill served by career guidance programs designed for men, and that they move more frequently into non-traditional careers when presented with the role-model of a successful women (Hall, 1983). To this end, women's colleges, such as Radcliffe College, have established specialized career guidance centres. They have also established career internships and externships designed to provide women with potential mentors.

We are unaware of any similar, university-based, Canadian program, although Bethune College at York University has recently made a move in this direction. Many of the professional organizations that serve women scientists and engineers informally provide these services. The Canadian Association of Women in Science (CAWIS) and Women in Science and Engineering (WISE) are currently attempting to establish a directory of women scientists and engineers, one function of which would be to promote women job candidates.

iii) Re-Entry and Career Change Programs

Women need more of the same kinds of training provided to men. They also need training suited to their particular situation. Younger women may need opportunities for part-time training. Older women may be looking for opportunities to re-enter the work force or, increasingly, for a chance to move to a more challenging career. These women may need "remedial" math, or courses in tool-handling, or a program to build self-esteem. Whatever the specific needs, older women are often more interested in non-traditional work than young women straight out of high school. Therefore, re-entry and career programs for women are absolutely central to any strategy for increasing the participation of women in science, engineering or technology related careers.

Most successful programs for career change or re-entry have some of the following components:

- bridging which, among other things, builds self esteem, teaches basic numeracy and tool-handling skills (Quinta Consulting Group, 1987).
- some financial support for the trainee.
- childcare subsidy.
- geographically accessible location (for example, close to public transit).
- consideration for quality of work issues (Avebury, 1986; Booth, undated).
- training designed for relational learners, the learning style to which women in this culture are predominantly socialized (Belencky, 1986; Gilligan, 1982). For example, the instructor should be encouraging of and involved with participants; material presented should make a connection between what is already known and what is to be learned; time should be allowed for verbal processing of the material; there should be opportunities for hands-on application.

Re-entry and career change programs are needed at all levels. The City of Toronto Bridges Program - an employer based program directed to the manual occupations - and the Arizona State University Career Change Program in Engineering - a university based, professional program, provide two very different models. These programs, which are described more fully in the Appendix, offer older women the technical and psychological skills they need to enter the trades and professions.

D) RECRUITMENT VS. RETENTION

Mentoring and networking programs, career re-entry programs, and training programs all help to recruit women into MMSET, but recruitment is only one source of women's uneven representation in the MMSET workforce. Programs to recruit women often focus on women themselves as the problem, seeking to change their attitudes or enhance their expertise without making relevant changes elsewhere in the system:

> It's built-in . . .this idea that they . . .the trainees are broke and that we (the trainers) are going to fix them. But of course there's nothing wrong with these women really and it's impossible to expect a 9 or 12 month program to catapult them into $30,000/year jobs . . . (Instructor in a training course for women, quoted by Wismer, 1988).

Some analysts of women's work in MMSET believe that it is the scientific and technologic professions rather than the women that "are broke," and as numerous programs aimed to increase women's participation in MMSET by increasing recruitment and training of women have fallen short, a new issue has emerged - namely retention.

Studies of the current crisis in Canadian nursing repeatedly indicate that a "shortage" of trained nurses is not the root of the problem. More than enough trained nurses live in Canada to staff the wards. The difficulty is that few of these want to continue working in the nursing profession (Armstrong,1988 b; Melz, 1988; White, 1990). "Drop out" similarly plagues other professional and para-professional areas of science, engineering and technology. Between 1948 and 1988, 6424 Canadian women received Bachelor's degrees in engineering. By 1988, more than 50% had left the profession (they were no longer registered as professional engineers). The corresponding figure for male engineers is about half that, 28% (Baigneé, 1990b).

Similar sorts of attrition can be found among women graduates in the health and medical sciences. These women have traditionally found jobs in academia, medical practice and industry. In none of these areas is the representation of women in the workforce commensurate with the number of graduates. As is the case with women engineers, larger percentages of female than male physicians become "inactive" (18.6% female to 7.6% male). A particular problem among older women physicians, this pattern is also apparent among the younger age cohorts. Regarding physicians under 35 years of age, 4.4% of female, as compared to 1.3% of male, declared that they were "inactive". Similarly, larger percentages of female physicians work part time. While 96% of male physicians, under the age of 35, reported that they worked full time, only 74.9% of female physicians did so. The percentage of part-time female physicians also increased for the older age cohorts (Ryten, 1986).

Attrition likewise occurs in the academic setting. A large percentage of the master's degrees awarded in the health sciences go to women, but a very small proportion of those women who complete master's level study go on to complete a Ph.D. Many of those who do receive degrees have difficulty attaining fellowships or securing academic jobs. A recent American study reported that "more women are earning doctorates in mathematics, but few are being hired by top universities" (Turner, 1989).

Canadian women trained in MMSET find it equally difficult to secure academic employment. In Ontario, only 12% of medical faculty are women. This is significantly lower than the percentage of women in academic positions overall (17.6%). The representation of women among science faculty is still worse. In Ontario, in 1987, only 13.5% of full-time professors in animal biology, 9.8% of professors in microbiology/biochemistry, and 12.6% of professors in botany were female. The percentage of full-time female faculty dropped to 7.5%

in chemistry, 6.6% in math, 4.5% in earth science, 2.9% in applied science, and 2.2% in physics. The representation of women at the higher academic ranks is lower still. Given these prospects for employment and promotion, it is little wonder that some of Canada's "best and brightest" drop out. Still, the loss of such a large number of extraordinarily motivated and gifted women - who have already surmounted tremendous obstacles - is appalling (Royal Society, 1989).

Why the loss? As Baigneé suggests, "it is not so much a female problem as it is an engineering or a science problem". We believe that the climate of the workplace is much like the climate of the classroom; a complex set of forces operates which tends to deny women their talents. The culture and practices of science and technology affect the quality of their working life and the status of the work they do. Recent initiatives to "reform" science may also place an undue burden on women.

i) The Scientific "Double Day, Double Bind"

All working women are victims of the "double day, double bind" (Ganage, 1988) but the tensions, generally compounded for women in non-traditional careers, take new shape for women in science. A recent article on the scientific "circuit" (an endless round of scientific meetings and seminars that is critical to professional advancement) suggests that, in MMSET, women with families are at a particular disadvantage. In the words of cell biologist Dr. Joan Ruderman: "You feel crummy being away so much and being away on weekends. And part of being on the circuit is 'yukking it up with the good old boys,' a pastime that tends to exclude women" (Kolata, 1990). Many scientific and engineering careers require extraordinary commitments of time and travel away from home, because equipment needed to perform experiments is not easily moved. The expectation that successful scientists will travel extensively and spend long hours in the laboratory disadvantages both male and female practitioners of the discipline, but it poses special problems for women who, despite recent changes in the division of household labour, continue to perform the majority of work done within the home (Luxton, 1985). Moreover, the dual burden of taking one's show on the road and constantly struggling to be "one of the guys" creates great pressure for women. This pressure may help to explain the relatively higher number of women engineers and scientists in government jobs, which tend to have shorter and more regular hours.

ii) The Prestige of Science and Women's Careers

The culture of scientific work creates unique tensions for women who struggle to balance home and career, and as the discussion of re-entry provided above indicates, presumptions about scientific genius and scientific achievement affect women's entry into scientific careers. Presumptions about science additionally affect the attrition of women from careers in MMSET.

Discussions of women's non-traditional careers tend to focus on better salaries, but women are motivated to work in non-traditional areas for many reasons other than pay. The City of Toronto career change program described in the Appendix (Quinta Consulting, 1987) found the major determinants of women's participation included quality of working life factors, new opportunities, knowledge and skill, but not higher salary. Other North American studies suggest that men and women measure "occupational prestige" differently (Greene, 1989; Tyree and Hicks, 1988; Dalton and Marcis, 1987; Brush et al., 1987; Clement, 1987). A Canadian study by Avebury Consultants (Avebury, 1986) indicated that women wanted interesting work that offered a sense of accomplishment.

These career aspirations are not always compatible with the culture of the scientific workplace. Standards for publication and funding of research privilege some forms of scientific inquiry over others. Studies with military or commercial applications are often given higher priority. Whether for philosophic reasons, or as a consequence of social, economic and political forces, women engaged less frequently in these research fields (Franklin, 1990; Stark-Adamec, 1990). North American women have organized, in disproportionate numbers, against corporate and military interests, and some of these women have backgrounds in MMSET. These women scientists find the corporate goals of private companies in the field of science, engineering or technology (for example, those involved with the production of pharmaceuticals or military technology) less than compatible with their value systems.

Presumptions of scientific genius and excellence similarly conflict with women's experiences and with their definitions of job satisfaction. The expectation that the "best candidate" received a degree young, got a job immediately, and pursued particular paths of research impedes women's progress through the ranks. When it comes time for promotion or advance, women must again demonstrate that they have complied with these standards of scientific excellence.

iii) Status: Invisible Women: Traditional Careers in Science and Technology

Studies of women in MMSET tend to focus on elite groups of professional women. Although women are generally disadvantaged in the labour force, most of the gains in women's employment in science and engineering have occurred at the professional level (e.g. among academics, engineers and physicians). Here, the beneficiaries are, by and large, able-bodied, white and middle class. Many studies (summarized in Avebury, 1986, Connely and Macdonald, 1990) have found that women with higher education and economic status are more likely to enter the workforce permanently and, because they hold less stereotyped views of gender appropriate work, to seek non-traditional employment. "Elitism" equates a career in health care with an M.D., or a career in technology with an engineering degree. However, professional women are not the only workers in MMSET. As Jo Sanders points out, it is a mistake to assume that a bachelor's or advanced degree is an essential prerequisite to a career in math and science (Sanders, 1989). Women work in droves as nurses, technicians, research assistants and computer operators.

No discussion of the participation of women in the science and technology workforce would be complete without recognizing women's traditional and important contributions in these characteristically invisible areas. The health care sector, one of Canada's largest and fastest growing employers, is largely dominated by these "invisible" women. Similarly, technicians and technologists already outnumber professional mathematicians, scientists and engineers. These women have not always shared the gains of their professional sisters. Though increasing in numbers, they continue to occupy a narrow stratum of the MMSET workplace. Technologic "advance" also impinges differently on these women. Rather than increasing the status of women in female-dominated sectors of MMSET, technology in many instances displaces them and makes room for men. This has been true in nursing, and in the information processing sectors, where as technology redefines the content of work, women have lost jobs to men. Moreover, in nursing, men are rising more often and more rapidly into management and other positions of authority (Armstrong, 1988; Yalnizyan, 1986).

E) DOUBLY DISADVANTAGED

When assessing the technologic trades, it is also important to look at the "doubly disadvantaged". Most women are already disadvantaged in the labour force, but poor women, immigrants, the disabled, Natives and other minorities and those who are geographically isolated carry a double burden. These "doubly disadvantaged" women are often the ones who become nurses, technicians and technologists. Though women of British extraction still represent the majority of workers in the MMSET workplace, during the past decade francophone and visible minority women have steadily increased their presence in the trades. Increasing numbers of Black, Asian, Southern European and Native women now work as nurses, medical technologists, and data processors. These women, in turn, are becoming a significant percentage of these sectors of the MMSET workforce (Figure 21).

The movement of visible minority women into MMSET jobs reflects recent patterns of immigration and the new socio-economic status of immigrants. It also reflects broader economic trends. Increasing numbers of both first- and second- generation immigrant women are seeking employment. Jobs in MMSET offer them the opportunities they seek. This workforce is expanding, in part because those who traditionally worked in it are seeking employment elsewhere. Women technicians and technologists provide a key resource with which to address areas of employee and skill shortage. Minority women are moving both into areas previously dominated by male workers, and also into female jobs. As middle-class white women increasingly identify success with employment in the elite professions, they are shifting their career goals away from nursing and the applied technologies. Minority women have moved in to fill the gap. Over the past decade, the ethnic and class background of students enrolled in training programs at the Michener Institute of Medical Technology, at Ryerson and at other technologic institutes seems to have broadened (Personal communication, Lori Boyd, September 1990).

MMSET holds out the promise of jobs to minority and other "disadvantaged" women, but it is not clear that this promise is any less encumbered than it is for all women. Francophone, visible minority, disabled and poor women all encounter particular obstacles to their full participation in the MMSET workforce.

Figure 21

CANADA-WIDE PARTICIPATION IN MMSET WORK FORCE
BY % WOMEN AND ETHNIC ORIGIN, 1986

	Britain	French	Chinese	S. Asian
Administrators in Medicine & Health	28.6	18.4	0.7	0.5
Chemists	23.9	22.6	2.8	1.1
Geologists	27.2	8.9	5.0	0.0
Physical Science Technologists & Technicians	18.9	22.8	2.3	1.5
Agriculturists	17.7	26.0	0.8	1.0
Biologists	15.3	19.1	2.4	3.0
Life Science Technologists	14.0	29.2	2.4	0.7
Civil Engineers	18.5	12.9	2.8	0.0
Electrical Engineers	20.0	15.8	4.8	1.2
Industrial Engineers	20.8	24.0	1.9	1.1
Mechanical Engineers	22.7	14.9	2.8	0.7
Engineering Technologists & Technicians	22.7	16.7	3.1	1.9
Mathematicians, Statisticians etc.	20.4	19.3	3.3	1.3
Systems Analysts & Computer Programmers	15.9	26.7	5.8	2.0
Physicians & Surgeons	17.5	20.6	3.5	5.2
Dentists	13.8	19.5	5.7	1.8
Veterinarians	20.8	23.1	0.0	0.0
Pharmacists	18.6	22.0	9.3	3.2
Radiologic Techs & Technols.	22.0	24.0	0.7	1.1
Medical Techs & Technols.	18.1	20.3	2.3	1.4
Dental Techs & Technols.	17.3	15.3	4.3	0.0
Machinists	23.1	13.3	3.3	2.6
Industrial, Farm Equipment	27.4	17.7	0.0	1.8
Precision Equip.	39.0	6.8	1.6	4.7
Electrical	22.7	20.0	0.9	2.3
Electronic	23.7	16.8	3.8	2.4
Mechanics Motor.	0.3	17.2	1.5	1.5
Mechanics air.	NS	NS	NS	NS

Source: Statistics Canada

i) Francophone Women

Canada-wide, francophone women hold their own in the MMSET workforce (Figure 22). These women outnumber, proportionately, their anglophone sisters in the physical sciences, industrial engineering, systems analysis, and the medical professions and technologies. Whether the 719,425 francophone women who resided in Ontario, in 1986, fared as well is unclear (Statistics Canada, *Dimensions*, 1986).

For francophone women in Ontario, the problems of acquiring work in MMSET closely mirror those of attaining post-secondary education. The difficulties of receiving French-language instruction translate into job procuring difficulties. Both geographic and linguistic barriers impede the career progress of francophone women. The dearth of bilingual or French language institutions, in Ontario, limits their employment opportunities and career progress. As is the case for post-secondary education, success is measured in terms of participation in a small number of English institutions concentrated in southern Ontario.

ii) Native Women

Native women are also victims of the geographical constraints on employment in MMSET. Like francophone women, they must often travel significant distances from their homes to procure work in these fields. Similarly, linguistic barriers impede the career progress of Native women in the MMSET workforce. These linguistic and geographic barriers deny Native women essential opportunities for training and prevent them from acquiring the credentials they need to move through the workforce.

When assessing the participation of Native women in MMSET, we must also recognize that their cultural traditions have grown alongside, but apart from, Western science. Modern Western assumptions about causation, proof and utility can be quite alien to Native and other non-western cultures. So can the equation of technology with progress. For Native women, and men living on Ontario's reservations, western technologic innovation does not necessarily seem to correlate with an improved quality of living. Hence, their attitudes toward and motivations for entering MMSET might be very different from those of the urban, white, middle classes.

Those Native women who have chosen to enter the MMSET workforce also confront barriers of gender and racial discrimination.

iii) Visible Minority Women

Native women and Black women remain distinct minorities in the MMSET workforce. These women, like all working women, confront barriers erected against their gender, but they face additional barriers based on race and class. In some respects, the relationship between visible minority, disabled women and all working women mirrors the relationship between all working women and men. In the first instance, Black and Native women are a very small proportion of the MMSET workforce. Their representation in MMSET professions and trades is so low as to be insignificant, and hence is excluded from Figure 21.

Visible minority women are making gains in some areas of the MMSET workplace. As middle-class white women move out of nursing and health technologies, Black, Native and Asian women are swiftly moving in to fill the gap (Statistics Canada, *Dimensions;* Armstrong, 1988). Here, visible minority women encounter the same forms of sex discrimination that operate in other sectors of the workforce. They find that they are tokens; they are segregated in lower status, less well-paying, less prominent positions.

However, visible minority women also encounter tangible and more subtle forms of race discrimination. The dominant culture, which establishes standards for the gender and race characteristics of particular jobs, acts to further limit the opportunities of visible minority women. So do the minorities' own culturally conditioned standards of "appropriate" female behaviour. It is critical to note that not all visible minority women participate in the MMSET workforce with the same degree of disadvantage. Chinese and South Asian women, who are raised in traditions that permit participation in MMSET, fare significantly better in this workforce than do other visible minorities. Linguistic barriers also impede the progress of some of these women. Finally, the constellation of forces that has traditionally excluded visible minority women from post-secondary educational institutions continues to exclude them from elite positions in the workforce.

The Ontario Confederation of University Faculty Associations (OCUFA) has recently acknowledged this extraordinarily low level of participation and called for employment equity policies that target visible minority, disabled and native peoples. Though designed for use in universities, this policy can be applied to women at all levels of the educational system and the workplace. It calls for pre-recruitment strategies - including remedial courses, special scholarships and fellowships, and a "race-sensitive" curriculum - that will attract visible minority and Native women into training programs offering the skills needed to enter the workforce. OCUFA further proposes the creation of an environment that will "encourage [visible minority, native and disabled peoples] to remain and succeed." Their proposal includes both symbolic statements and concrete recommendations for change (OCUFA Forum, Nov. 1990).

iv) Disabled Women

Disabled women face many of the same barriers to entry into the MMSET workplace as visible minority women. These include, in particular, cultural biases about their capabilities. Culturally determined preconceptions about the appropriateness of individuals for certain jobs, and similar preconceptions about the necessary qualifications for these jobs, often exclude disabled women. For example, the assumption that a lab technician must be mobile disadvantages women in wheelchairs. Yet, with the proper equipment, and the proper modification of equipment, women in wheelchairs are perfectly capable of drawing blood and analyzing it.

Physical inaccessibility is the greatest barrier to disabled women's participation in the MMSET workplace. Equipment is placed too high. Space is arranged in ways that are difficult to manoeuvre. Physically taxing work protocols are considered the norm. Employers lament the costs of changing the workplace to accommodate the physically disadvantaged, but the costs of building a lower workbench are not great, and the rearrangement of space and work protocols can be of advantage to all workers.

F) BRINGING ALL WOMEN BACK INTO THE TECHNOLOGIC TRADES

There is a need for training programs which could draw on the interest and aptitudes of the minority women, older women, and disabled women who are entering the workforce and increase their recruitment into the technical trades. Salaries in these technical fields - particularly those currently dominated by males - are relatively high. Hence, jobs in these sectors offer women a form of economic mobility. Better pay, improved working conditions, and fuller utilization of the skills of women who work as technicians and technologists are also essential. Finally, there is a need for increased recognition - particularly from other working women. As recent studies of Ontario's nurses indicated, their grievances have less to do with salary than with the respect accorded their work (Armstrong 1988, 1988b). Thus by continuing to ignore women's contributions or potential contributions in the semi-professions and technical trades, we ignore both a valuable resource and continue to perpetuate the flawed myth that only "real men" do technology.

Improving the working conditions and status of nurses and other women-dominated technical fields is not a frill. As the current crisis in Ontario nursing indicates, shortages of such workers can impact adversely on Ontario's economy and on the health care of Ontario residents. Here, however, a persistent problem re-emerges. Analyses of women's participation in MMSET - such as those of the current crisis in nursing of the technical trades - have obviously and necessarily been guided by economic concerns about labour shortages and declining skill. Hence, there has been a tendency to focus on the question of what more women in the MMSET labour force will do for the competitive position of Ontario. There is also the need to ask what jobs in MMSET can do for women.

Related to this is the need for analysis of the concept of choice. While it is sometimes presumed that women choose to work, or not work, in certain fields at certain times, recent scholarship suggests that women work for most of the same reasons that men do (Connely and Macdonald, 1990; Armstrong and Armstrong, 1978). We need further investigations which would focus on the actions women have taken to shape their own futures and on the economic and social forces - most particularly status and the quality of working life - that delimit these actions.

G) DE-SKILLING AND TECHNOLOGICAL OBSOLESCENCE

While emphasising how important it is to improve women's technical and technological skills, it is also important to remember the double edged sword that technology represents for women's working lives. The technological expertise required to perform a task provides a measure of skill that affects the prestige assigned the task and its monetary worth. Hence, in some disciplines, health care chief among these, "technique" is used as a filter that excludes women from professions (Armstrong, 1984; Armstrong and Armstrong, 1978; Cockburn, 1985). Measures of technologic skill also affect salaries. As a recent pay equity study of Ontario's nurses indicated (Armstrong, 1988), the boundaries to nurses' work are not clearly defined. Technology helps to create ambiguities in status and responsibility, within nursing work, that in turn provokes both economic and personal dissatisfaction. Nurses receive little recognition for the skill their work involves, a problem that is exemplified in the practice of not providing them with full credit for years of experience when they move from one hospital to another (Armstrong, 1988; 1988b; Melz, 1988). Clearly, too, the example of other developing and developed nations indicates that nurses and nurse-practitioners are quite capable of performing and delivering, in a highly effective and more cost-efficient manner, many of the services now within the jurisdiction of physicians. But the presumption that technical tasks - such as the starting of a drip - are best performed by physicians or other technically trained staff - has led to a steady reassignment of such tasks away from nurses.

Technology also affects women's work adversely through the creation of job obsolescence. Occupations dominated by women, such as clerical occupations, are being altered or eliminated by computer technology at a greater rate than occupations dominated by men. A recent Ontario task force found that almost all industries expect to reduce their clerical staff by 1995. Much the same holds true in the health care sector, where analyses once performed by female technicians and aides are now done by computer (Armstrong, 1988).

H) CONCLUSION: THE PERCEPTION THAT WOMEN WILL CHANGE SCIENCE

Professional women are less affected by concerns about status or job obsolescence than women in the trades, but they bear another burden. As the opening quote from Ursula Franklin indicates, there is a growing feeling that many of the actual shortcomings of science and technology - the hierarchical organization, the closed mindedness, the competitiveness, the focus on destructive and controlling applications - are rooted in the lack of a female presence. In her novel, *A Room of One's Own*, Virginia Woolf once quoted Coleridge's[4] claim that the best writing is androgynous. Perhaps the same could be said of science, engineering and technology. Too few women currently work in most scientific disciplines. Hence, they have not yet become a critical mass, and it is too early to determine whether women will change the face of MMSET. Nonetheless, many students of the subject have come to ask whether women will change the practice of science and technology, or whether science and technology will change the women (Franklin, 1985).

---

[4] Samuel Taylor Coleridge was a British poet

Efforts to reform the nature and content of scientific practice, and efforts to attract more women in MMSET are laudable but there is reason for concern about the equation of these two goals. First, as the question asked by Ursula Franklin indicates, it is unclear whether women will change MMSET or vice versa. Women have already made significant inroads into some fields, such as bio-medicine. In some of these bio-medical fields, a critical mass of women does exist. These fields provide an opportunity to assess whether or not women can or want to single handedly change the face of science.

Women now represent 47% of Ontario's medical graduates; they are 52% of pharmacy students. Of the pharmacists licensed to practice in Ontario, 40% are women. These represent significant gains, particularly when compared to the United States, where women represent a mere 19% of practitioners. The preponderance of women in these disciplines does not seem to have significantly changed practice. Across Canada, women physicians seem to work fewer hours at less lucrative sub-specialties. While these differences in behaviour "promise to transform medicine" women's patterns of practices do not seem to be tied to a wholesale philosophic preference for more humanistic or community-based forms of medical practice. (Williams et al., 1990). Younger Canadian women physicians are slightly better represented in the specialty of community medicine (33%), but not in the field of public health (Royal College of Physicians and Surgeons, Statistics, 1989). In general, women seem to practice medicine for the same reasons as men, and the proliferation of complaints about female physicians who appear to be "no different than men" suggests that they operate similar practices. A recent study of physician practices in greater Toronto suggests that women physicians' office and on-call hours are as few and inflexible as their male colleagues' (Feldberg and Pfeiffer, forthcoming).

Likewise, in pharmacy, no significant difference in employment patterns or practices seem to exist between the sexes. Nor are female pharmacists uniformly less attuned to corporate goals, or more attuned to the hazards that pharmaceutical products pose for women (Lexchin, 1989; DesRoches, 1985). The official publications of organizations designed to represent the interests of women physicians and pharmacists further suggest that they, like other professional women, are primarily preoccupied with securing their own professional futures. The OMA committee on women in medicine, for example, offers advice appropriate to any self-employed women. It advises on the best means of acquiring maternity benefits, childcare, and other forms of insurance.

Yet, patients expect women physicians and pharmacists to be different, and they expect them to transform the system. A recent article by Caroline Walter in the *Journal of the American Medical Women's Association* acknowledged the plight of the woman physician in a community, feminist practice. Trained to believe that they are authorities, women physicians have as much difficulty relinquishing control to nurses and patients as do their male colleagues. Yet, this co-operative practice is the central tenet of the new women's health. Disappointment with the women physicians who fail to meet the higher standard abounds, in part because it is culturally easier for us to criticize women. Outside the classroom as within, these tensions serve to alienate professional women from those they attempt to serve (Feldberg, 1989).

To require women physicians, pharmacists, engineers and other scientists to singlehandedly and simultaneously both establish their professional identities and transform scientific practice is unrealistic. It might well add additional stresses to the lives of the women employed in these professions. To expect a junior woman researcher to show a preference for "green" - or environmentally friendly research - when industrial and military research are better funded and respected, is to ask her to be at once a minority and a maverick. The burden is too heavy because it makes women responsible for any failure to change the system.

Hence, we need to separate our vision of a "new" science from our efforts to attract more women into MMSET. As Marsha Hanen recently noted:

> Whether such openness [to women in MMSET] will change anything in the disciplines or lead to better science and technology is an open question. At the very least, it may help us to improve the level of knowledge of science and technology among Canadians. At best, it may be transformative in ways that will lead us to solutions to some of society's economic and social problems. This has to make it worth a try.

It is important, however, to simultaneously recognize that the sorts of economic, social and political forces that act as barriers to women's entry into MMSET also shape the content and nature of scientific practice, and to encourage measures that will facilitate the transformation of both.

APPENDIX

Model Career Change and Re-Entry Programs

The City of Toronto Bridges Program: Employer-Based Career Change Program

This pilot program designed by the Equal Opportunity Division of the City of Toronto, provides a comprehensive model for addressing issues of equal employment opportunity and quality of work life while providing training suited to relational learners. The objectives of the program were to provide female employees with an opportunity to experience non-traditional occupations within the corporation by immediate managers and co-workers (attitudinal change.) The program also facilitated organizational change indirectly, by providing a "bridge" between traditional, clerical occupations and manual, non-traditional jobs where none had existed previously.
The program included the following components:

- pre-course unit which included an information session and personal interviews;
- unit 1, which involved tours of non-traditional work sites in the City, interest and aptitude assessments, and personal goal setting;
- unit 2 which included discussions and practice with issues related to non-traditional workplaces, i.e., health and safety, self-confidence, sexual harassment, and assertiveness;
- unit 3, which involved the acquisition of tool skills, hands-on experience of basic techniques in construction, electrical wiring, etc. and specific in-house training in the actual work environment; and
- unit 4, which provided a three-week, hands-on work placement in a non-traditional job.

All units, except unit 4, were offered sequentially, for one day per week, over a six month period. Within a month of the end of the program, 8 of 12 "graduates" had applied for a position in the non-traditional fields within city hall, and one had registered for an 18-week Women into Trades and Technology program at a community college. According to its evaluators, the BRIDGE program met its major objectives for reasons that included: (Quinta, 1987):

- upper management support;
- the high profile, experimental nature of the program;
- training and implementation methodology;, and
- calibre of the instructors.

Arizona State University Career Change Program in Engineering

Although there are many notable examples, in the United States, of university-based, re-entry opportunities for women (e.g. the Bunting Institute at Radcliffe College, Harvard University), we are not aware of any specific programs in Canada. One model which is particularly relevant to this discussion - and which appears worth emulating - is the Graduate Career Change Program in Industrial Engineering at Arizona State University. This program enables women who are unemployed or who work in a non-technical field to obtain a Master of Science in Engineering (MSE) degree in industrial engineering within two years. Participants, who all have bachelor's degrees, come from a variety of backgrounds. These include mathematics, education, medical technology, English and psychology. The program includes a good deal of peer support and a regular professional development seminar as well as work placements. Initial support came from the National Science Foundation, which has also funded other re-entry and career development programs for women scientists and engineers.

BIBLIOGRAPHY

Ainley, M.G. ed. Despite the Odds. Montreal: Vehicule Press, 1990.

Ainley, Marianne Goztonyi, "Last in the Field? Canadian Women Natural Scientists, 1815-1965," in Ainley, Despite the Odds, pp. 63-73.

Ainsworth, Lynne. "Students Shun Science for the Arts" Toronto Star. (Toronto), July 11, 1990.

Aisenberg, Nadya and Mona Harrington. Women of Academe: Outsiders in the Sacred Grove. Amherst: University of Massachusetts Press, 1988.

Allen, B. and James F. Niss, "A chill in the college classroom," Phi Delta Kappan (April '90) 71:607.

Anderson, Earl V. "Canada grapples with its science and technology policy" Chemical and Engineering News (March '89) 67: 7.

Anderson, Mary R., "The Career Change Woman Engineer", in Proceedings of GASAT 5 Conference. Volume 2. Edited by Israela Ravina and Yael Rom, Haifa: Technion-Israel Institute of Technology, 1989.

Armstrong. J.A. National Assessment of Achievement and Participation of Women in Mathematics. (Eric Document Reproduction No. ED 187 562), 1979.

*Armstrong, Pat. Pay Equity in Predominately Female Establishments: Health Care Sector. Report prepared for the Pay Equity Commission, Province of Ontario. Toronto: Ontario Pay Equity Commission, 1988.

Armstrong, Pat. "Where have all the Nurses Gone?" Healthsharing (1988b) 9:17-19.

Armstrong, Pat and Hugh Armstrong. A Working Majority: What Women Must do for Pay. Ottawa: Ministry of Supply and Services, 1983.

Armstrong, Pat and Hugh Armstrong. The Double Ghetto: Canadian Women and Their Segregated Work. Toronto: McClelland and Stewart, 1978.

Armstrong, Pat. Labor Pains: Women's Work in Crisis. Toronto: Women's Press, 1984.

Avebury Research and Consulting Ltd. Decade of Promise: An Assessment of Canadian Women's Status in Education, Training and Employment. Toronto: CCLOW, 1986.

Axelrod, Paul. Scholars and Dollars. Toronto: University of Toronto Press, 1982.

Axelrod, Paul. Making a Middle Class: Student Life in English Canada During the Thirties. Montreal: McGill-Queens, 1990.

Baigneé, Alison. "Women in Engineering - Then and Now" Indicator 2(4), 1990.

Baigneé, Alison, Enrolment and Degrees Awarded in Engineering, 1989. Ottawa: Canadian Engineering Manpower Board, 1990.

Baker, Dale R. "Masculinity, Femininity and Androgyny among Science and Non-Science majors." School Science and Mathematics (1984) 84:459-467.

Bakes, Alan and Sheinin, Rose. Who's Who of Women in/and Medicine in Toronto Since 1883. Toronto: Faculty of Medicine, University of Toronto, 1986.

Basalla, George. "Pop Science: The Depiction of Science in Popular Culture" in G. Holton, ed. Science and its Public. Dordrecht, Holland: Reidell, 1976.

Belencky, Mary Field et al., Women's Ways of Knowing. New York: Basic Books Inc., 1986.

Bem, Allen and James F. Niss, "A chill in the college classroom," Phi Delta Kappan (April '90) 71:607.

Benbow, Camilla and Stanley, Julian. "Sex Differences in Mathematical Ability: Fact or Artifact?" Science (1980) 210:1262-1264.

-------"Consequences in High School and College of Sex Differences in Mathematical Reasoning Ability: A Longitudinal Perspective." American Educational Research Journal (1982) 19:598-622.

Bentson, Margaret. "Feminism and the Critique of Scientific Method." in Angela Miles and Geraline Finn, ed. Feminism in Canada: From Pressure to Politics. Montreal: Black Rose, 1982.

Berger, Joseph. "All in the Game." New York Times, education supplement, August 27, 1989. p. 23.

"Big Science, Big Thinking, The National Interest," Transcript of the A. W. May Address. Vital Speeches, (Dec. 1 '89.) 56:114.

Biggs, C. Lesley. "The Case of the Missing Midwives: A History of Midwifery in Ontario from 1795-1900." Ontario History (1983) 75:21-35.

Bleir, Ruth, Science and Gender: A Critique of Biology and its Theories of Women. New York: Pergamon, 1984.

--------"The Relations between Science and Women's Studies." in S. Rosser, ed. Feminism within the Science and Health Care Professions: Overcoming Resistance. Oxford: Pergamon, 1988.

Booth, Susan and Carol Brooks eds. Adult Learning Strategies: An Instructor's Tool Kit by Ontario Adult Educators. Toronto: Ontario Ministry of Skills Development, undated.

*Bournival, Marie Thérèse. "Profession? Femme des sciences!" Gazette des Femme, Conseil du Statut des Femmes (1986) 8:8-15.

Briskin, Linda. Feminist Pedagogy. Toronto: York University. Institute for Social Research, 1990.

Brush, Donald et al. "Individual demographic differences and job satisfaction," J. Occupational Behaviour (April '87) 8:139.

Canadian Association for Women in Science. Touching the Unknown: An Audiovisual presentation on Canadian Women Scientists (Toronto, 1985).

Cantwell, Mary. "Remembering college: study, bridge, work, love," New York Times (April 19, 90), p. B6.

Caplan, Paula. "Gender Issues in Diagnosis." paper to the First Canadian Conference on Gender, Science and Medicine. Toronto, November 5, 1988.

Carnevale, Anthony P., Gainer, Leila J. et al. "Workplace Basics: the skills employers want" Training and Development Journal (1988) 42:22.

Carter, Ruth & Kirkup, Gill. Women in Engineering: A Good Place To Be? London: Macmillan, 1990.

Chauvin, Marny. "Women in Science - What Schools Can Do." Comment on Education (1987) 17:19-25.

*Ching, Hilda Lei, ed. Proceedings of the First National Conference for Women in Science, Engineering and Technology/Actes de la Premier Conference Nationale des Femmes dans les Sciences, le genie et la technologies. Vancouver: Society for Canadian Women in Science and Technology, 1983.

Chu, Clara M. and Macdonald, Bertrum. "The Public Record: An Analysis of Women's Contributions to Canadian Science and Technology Before the First World War" in Marianne Ainley, ed. Despite the Odds.

Clarke, Edward H. Sex in Education; or A Fair Chance For the Girls. Boston, 1873.

Clement, Sarah. "The Self efficacy expectations and occupational preferences of female and males," J. Occupational Psychology (Sept. '87) 60:257.

Coates, Jennifer. Women, Men and Language. 1986.

Cockburn, Cynthia. Machinery of Dominance: Women, Men and Technical Know-How. London: Pluto Press, 1985.

Cohen, Fay Goodman and Okigwe, Carla McCulloch. "Bitter Memories: Voices from the Class of 1965" Radcliffe Quarterly (Sept. 1990) 76:24.

Cole, K.C. "Science Under Scrutiny." N.Y. Times (New York), January 7, 1990.

Collis, Betty. "Adolescent Females and Computers: Real and Perceived Barriers." in Despite the Odds. Edited by M.G. Ainley, Montreal: Vehicule Press, 1990.

*Connely, Pat and Martha Macdonald, Women in the Labour Force. Ottawa: Ministry of Supplies and Services, 1990.

Conroy, Mary. "Where have all the smart girls gone?" Psychology Today (April '89) 23:20).

Cooper, S. E. and Robinson, D. A. G., "Students in Highly Technical Careers: Sex Differences in Interpersonal Characteristics and Vocational Identity." Journal of College Student Personnel (1985) 26:215-219.

Cornelius, Randolph and Janet Gray, "The Chilly Climate: Fact or Artifact?" Journal of Higher Education (Sept. Oct. '88), 59:527.

Daag, Anne Innis and Thompson, Patricia. MisEducation: Women and Canadian Universities. Toronto: OISE, 1988.

Daag, Anne. "Women in Science, Are Conditions Improving?" in Ainley, Despite the Odds (1990) pp. 337-348.

Dalton, Amy and John Marcis, "Gender Differences in Job Satisfaction among young Adults," J. Behavioral Economics (Spring '87) 16:21.

Daniels, Arlene Kaplan. "Invisible Work" Social Problems (Dec. '87) 34:403.

Dayton, Leigh. "Barriers Erected by Male Engineers Keep Women Away from Profession." Globe and Mail January 13, 1990.

"Declining female enrollments threaten the gains of the early 1980's," Aviation Week and Space Technology, Dec. 5, 1988, p. 41.

Decore, A. M. "Vive la Difference: A Comparison of Male-Female Academic Performance," Canadian Journal of Higher Education (1981) 14:35-57.

de la Cour, Lykke and Sheinin, Rose. "The History of the Ontario Medical College for Women: 1983-1906. Lessons from gender-separatism in medical education." Can. J. Women's Studies (1986).

DesRoches, Bernie. Women in Pharmacy: A 1984 Perspective. Toronto: Ontario College of Pharmacists, 1985.

Dweck, Carol et al. "Sex Differences in Learned Helplessness: II The Contingencies of Evaluative Feedback in the Classroom and III An Experimental Analysis" Developmental Psychology 14 (1978).

Dresch, Stephen P. and Kenneth R. Janson, "Recruitment and accomplishment in fundamental science: a generalization of the Giants, Pygmies model" Technological Forecasting and Social Change (March '90) 37:39.

"Educators Sceptical About Merits of Scientific Literacy Survey". Globe and Mail, March 2, 1990, A.11.

Ehrhart, Julie Kuhn and Bernice R. Sandler. Looking for More Than a Few Good Women in Traditionally Male Fields. Washington, D.C.: Project on the Status and Education of Women, Association of American Colleges, 1987.

Eichler, Margrit and Reisman, Anna Lisa, "Sexism in Medical Science Research" paper to the First Canadian Conference on Gender, Science and Medicine. Toronto, November 5, 1988.

*Ellis, D. and Sayer, L. When I Grow Up: Career Expectations and Aspirations of Canadian Schoolchildren. Ottawa: Minister of Labour, 1986.

Ellis, D. "Rite Models, Career Expectations and Counselling," in Furguson, Who Turns the Wheel (1982) pp. 75-85.

Englemann, George. The American Girl of Today: Modern Education and Functional Health. Washington, 1900.

Fausto-Sterling, Ann. Myths of Gender. New York: Basic Books, 1985.

Feldberg, G., and P. Pfeiffer, "A Patient's view of Physician Accessibility." forthcoming.

Feldberg, Georgina. "Entry Barriers to Women in Science and Medicine." paper to the First Canadian Conference on Gender, Science and Medicine. Toronto, November 5, 1988.

Feldberg, Georgina. "Tensions between Science and Feminism and Barriers to Canadian Women's Entry into Science and Medicine." Paper to the Toronto Area Women's Research Colloquium, November 1989.

Feldman, Diane. "Choosing between science and motherhood." Management Review (Feb. '89) 78:10.

*"Femmes et Science/Women and Science." Resources for Feminist Research/Documentations sur la recherche Féministe (November, 1986).

Fischer, Linda. "Science and the Environment of Young Girls" in Who Turns the Wheel. edited by Janet Ferguson, Ottawa: Science Council of Canada, 1982.

Fiske, Edward B. "Even at a former women's college, male students are taken much more seriously a researcher finds," New York Times (April 11, 1990), p. B6.

Ford, Ann Rochon. A Path Not Strewn With Roses: Women at the University of Toronto, 1884-1984. Toronto: University of Toronto, 1985.

Francis, Diane. "New Concerns about the Brain Drain," Macleans (Feb. 26, '90) 103:9.

Franklin, Ursula. The Real World of Technology. Montreal: CBC Enterprises, 1990.

Franklin, Ursula. "Whatever Happened to Gender Bias?" address to the Second Conference on Gender, Science and Medicine. Toronto, November 2, 1990.

Franklin, Ursula. "Will Women Change Technology or Will Technology Change Women?" (1985).

French, Orland. "Study Explores Myths of Math and Gender." Globe and Mail (Toronto) January 24, 1990, pg A4.

French, Orland. "Teaching Math to Teachers." Globe and Mail (Toronto), March 24, 1990, p. D2.

Furguson, Janet. Who Turns the Wheel? Proceedings of a Workshop on the Science Education of Women in Canada. Ottawa: Science Council of Canada, 1981.

Ganage, Charlene. Double Day, Double Bind. Toronto: 1988.

Gillet, Margaret. We Walked Very Warily. A History of Women at McGill. Montreal: Eden Press, 1981.

Gilligan, Carol. In A Different Voice. Cambridge: Harvard University Press, 1982.

Gilligan, Carol, Nona P. Lyons and Trudy J. Hanmer (eds). Making Connections: The Relational World of Adolescent Girls at Emma Willard School. Troy, New York: Emma Willard School, 1989.

Gold, Karen. Get Thee To A Laboratory. New Scientist 14 April (1990): 42-46.

Greene, Robert J. "Determinants of Occupational Worth; understanding the elements that define job value" Personnel Administrator (August '89) 34:123.

Gumpertz, John. Language and Social Identity. Cambridge: Cambridge University Press, 1982.

Haggerty, Sharon M. "Secondary Science Education in Canada: Participation of Girls in Elective Science Courses" in Proceedings of the CEMSAT Symposium. Edited by Pat Rogers, Toronto, 1989.

Hall, Roberta M. The Classroom Climate: A Chilly One for Women. Washington, D.C.: Project on the Status and Education of Women, 1982.

Hall, Roberta M. Out of the Classroom: A Chilly Campus Climate for Women? Washington, D.C.: Project on the Status and Education of Women, 1984.

Hall, Roberta M. Academic Mentoring for Women Students and Faculty: A New Way to Get Ahead. Washington, D.C.: Project on the Status and Education of Women, 1983.

Hamilton, Jean. "Biases in Women's Health Research: How far have we come and where do we go from here?" paper to the First Canadian Conference on Gender, Science and Medicine. Toronto, November 5, 1988.

Hanen, Marsha. "Women in Science and Technology: The Why Matters As Much As The How" University Affairs. (Toronto) June-July, 1990, pg 48.

Hannah, Gila. "An International Perspective on Gender Differences in Mathematics" in Proceedings of the CEMSAT Symposium. edited by Pat Rogers, Toronto, 1989.

Hartnett, Rodney. "Has there been a graduate student 'brain drain' in the arts and sciences?" Journal of Higher Education (Sept.-Oct. '87) 58:562.

Heath, Julia and Tuckman, Howard. "The impact of labor markets on the relative growth of new female doctorates" J. Higher Education (Nov. Dec. '89) 60:704.

Herring and Lafontaine. "Marketing Non-Traditional Jobs to Girls and Women". Women's Education, Fall (1986): 20-24.

"High Test Scores Don't Bring Confidence, Automatic Success," The Stanford Observer (November 1984:3).

Hildebrand, G. "Gender Inclusive Science Education: The Work of the McClintock Collective" in Proceedings of GASAT 5 Conference edited by Israela Ravina and Yael Rom. Haifa: Technion-Israel Institute of Technology, 1989.

Hubbard, Ruth; Henifen, Mary Sue; and Ried, Barbara, eds. Biological Woman - the Convenient Myth: A Collection of Feminist Essays and a Comprehensive Bibliography. Cambridge: Schenkman, 1982.

Hubbard, Ruth. "Comment on 'Is Science Male.'" in Ching, Proceedings, 1983, pp. 29-30.

Jeffrey, Adele. An Investigation Into Math Anxiety Among Elementary Teachers. North York: North York Board of Education, 1988.

Keegan, Patricia. "Playing Favorites." New York Times, education supplement, August 27, 1989, p. 26.

Keller, Evelyn Fox. "Feminism and Science." Signs (1982) 7:589- 602.

Keller, Evelyn Fox. A Feeling for the Organism. The Life and Work of Barbara McKlintock. New York: W. H. Freeman, 1983.

Kelier, Evelyn Fox. "Is Science Male?" in Ching, Proceedings, 1983, pp. 21-29.

Kenny, Shirley Strum. "College as Gateway to a job," J. of Commerce (Jan. 29, 1990) 383:8A.

Kimball, M. M. "Sex Differences in Intellectual Ability" in Furguson, Who Turns the Wheel.

Koch, Janice. "Educating the Educators" in Proceedings of GASAT 5 Conference . Edited by Israela Ravina and Yael Rom. Haifa: Technion -Israel Institute of Technology, 1989.

Kolata, Gina. "Mind Blowing? New York Times, education supplement, August 27, 1989, p. 25.

Kolata, Gina. "To Make the Big Time of Science, Better Take Your Show On The Road" New York Times January 2, 1990.

Kryhul, Anglea. "Set scientific research priorities, Canada urged at meeting of industry, labor and education leaders," Metalworking News (Feb. 1, '88) 15:8.

Landsberg, Michelle. Education 2000: A Vision For Our Schools In The Future. Toronto: Toronto Teachers' Federation, 1990.

Lee, Norm. Women In Science and Mathematics Workshop. Science Culture Canada, 1989.

Lewis, Lesley Vanessa. Women and the Colleges of Applied Arts and Technologies. Toronto: Ontario Ministry of Colleges and Universities, 1975.

Lexchin, Joel "Profits First: The Pharmaceutical Industry in Canada". Globe and Mail, Mar. 2, 1989, p. A3.

Luxton, Meg and Rosenberg, Harriet, G. Through the Kitchen Window: The Politics of Home and Family. (Toronto: Garamond, 1986).

Luxton, Meg. More Than a Labour of Love. (Toronto: The Women's Press, 1980).

Malcolm, Shirley M. "Who Will Do Science in the Next Century?" Scientific American Feb (1990): 112.

Malone, Thomas F. "To Lend Encouragement to Those Who Likewise Labor" American Scientist (Nov.-Dec. '88) 76:540.

Mandula, Barbara. "Is the SAT Unfair to Women?" Association for Women in Science Newsletter. 19(1), (1990): 8-10.

Mansnerus, Laura. "The S.A.T. Puzzle." New York Times, education supplement, August 27, 1989, p. 27.

Marsh, H. W., Smith, I. D. and Barnes, J. "Multidimensional Self-Concepts: Relations with Sex and Academic Achievement," Journal of Educational Psychology (1985) 77:581-596.

MacDonald, Eva and Webb, Elizabeth. "A Survey of Women Physicians in Canada, 1883-1964. "Canadian Medical Association Journal (1966) 94: 1223-1227.

McIntyre, G. Women and Ontario Universities. Toronto, 1975.

McMillen, Liz. "Women supporting women: fellowships from the AAUW fund over the past century have enabled 5,000 women to study," Chronicle of Higher Education (April 27 '88) 34:A32.

McMillen, Liz. "Clare Booth Luce Fund to spend 3.5 million a year to encourage women to study and teach science" Chronicle of Higher Education (July 5, 1987) 35:A23.

McPherson, Kathryn. Skilled Service and Women's Work: Canadian Nursing, 1920-1939. Ph.D. Thesis, Simon Fraser University, 1989.

Mead Margaret. "The Role of the Scientist in Society - III" in Lawson Lowry and Victoria Sloane, Eds. Orthopsychiatry, 1923 - 1948 Retrospect and Prospect (NY: American Orthopsychiatric Association, 1948) pp 367-373.

Mead, Margaret and Rhonda Metraux. "Image of the Scientist Among High School Students." Science (1957) 126:384-390.

Melz, Noah. The Shortage of Registered Nurses: An Analysis in a Labour Market Context. Toronto: Registered Nurses Association of Ontario, 1988.

Merton, Robert K. "Science, Technology and Society in Seventeenth Century England". Osiris (1938) 4:360-632.

Merton, Robert K. "The Matthew Effect in Science." Science (1968) 159: 56-63.

Meyer, Margaret. "The Teacher Variable in the Equity Education" in Proceedings of the CEMSAT Symposium. Edited by Pat Rogers, Toronto, 1989.

Minnich, Elizabeth, Jean O'Barr and Rachell Rosenfeld. Reconstructing the Academy: Women's Education and Women's Studies. Chicago: The University of Chicago Press, 1988.

Mohr, Ann. Brain Sex. London: Penguin, 1990.

*Mori, G.A. and B. Burke. Focus on Canada: Educational Attainment of Canadians. Ottawa: Ministry of Supply and Services, 1989.

Moore, Barbara G. Equity in Education: Gender Issues in the Use of Computers. A Review and Bibliography. Toronto: Queen's Printer for Ontario, 1986.

National Coalition for Women and Girls in Education. Education For All: Women and Girls Speak Out On the National Education Goals. Washington, D.C.: National Coalition for Women and Girls in Education, 1990.

Nevitte, N., Gibbins, R., and Codding, P. W. "The Career Goals of Female Science Students in Canada." in Ainley, Despite the Odds 1990 (pp. 284-303).

"No More MRS Degree" American Demographics, (March 1987), p. 16.

*Ontario Confederation of University Faculty Associations (OCUFA). Employment Equity for Academics in the Designated Groups: Visible Minorities, the Disabled and Native Peoples. OCUFA Forum (Nov. 1990).

Ontario Hydro. Women in Trades, Technical and Operators Task Force Report, 1986.

*Ontario Ministry of Colleges and Universities Statistical Summary. Toronto: Queen's Park. 1975-1989.

*Ontario Ministry of Colleges and Universities. Women and Ontario Universities (1975).

*Ontario Ministry of Colleges and Universities. Women and the Colleges of Applied Arts and Technology (1975,a).

Ontario Ministry of Education. Science is Happening Here. A Policy Statement for Science in the Primary and Junior Divisions. Toronto: Ministry of Education, 1988.

Ontario Ministry of Skills Development. Apprenticeship - A New View of the Future. Counsellor's Handbook. 1989.

Ontario Ministry of Skills Development. Ontario's Labour Market: Long Term Trends and Issues in the 1990's. Toronto, 1990.

Ontario Ministry of Skills Development. Training Women in the Workplace. A discussion document prepared for the Federal/Provincial/Territorial Ministers' Meeting, June 12, 1987.

Organization for Economic Co-operation and Development, Girls and Women in Education. Paris: OECD, 1986.

Powell, Doug. "How is Basic Science Faring in Canada?" Science (March 9, 1990) 247:1172.

Quinta Consulting Group. Program Evaluation Introduction to Non-Traditional Occupations: A Pilot Program Designed by the Equal Opportunity Division of the City of Toronto for Their Workforce. London, 1987.

Ravina, Israela and Rom, Yael. Proceedings of GASAT Conference. (Haifa: Technion-Israel Institute of Technology, 1989).

Rand, Donna and Gibb, Lydia H. "A Model Program for Gifted Girls in Science." Journal for the Education of the Gifted. 12 (1989): 142-155.

Report of the Royal Commission on the Status of Women in Canada, 1970.

Robertson, Heather-Jane. *The Idea Book: A Resource for Improving the Participation and Success of Female Students in Math, Science and Technology.* Ottawa: Canadian Teachers' Federation, 1988.

Rosenberg, Charles and Carol Smith-Rosenberg. "The Female Animal: Medical and Biological Views of Woman and her Role in Nineteenth-Century America. " *Journal of American History* (1973) *60*:332-365.

Rossiter, Margaret. *Women Scientists in America: Struggles and Strategies to 1940.* Baltimore: Johns Hopkins, 1982.

Royal College of Physicians and Surgeons of Canada, *Fellows in Good Standing,* 1989.

*Royal Society of Canada. *Plan for Advancement of Women in Scholarship.* Ottawa: Royal Society, 1989.

*Ryten, E. *Enrolment in and Graduation from Canadian Faculties of Medicine, 1985/6.* Ottawa: Health and Welfare Canada, 1986.

Sadker, Myra P. and David M. Sadker. *Sex Equity Handbook for Schools.* New York: Longman Inc., 1982.

Sanders, Jo. "Elitism in Math and Science Hurts Women" in *Proceedings of GASAT 5 Conference.* Edited by Israela Ravina and Yeal Rom, Haifa: Technion-Israela Institute of Technology, 1989.

Sangster, Sandra. *Effect of Sex-Segregated Mathematics Classes on Student Attitudes, Achievement and Enrollment in Mathematics.* Toronto: North York Board of Education, 1988.

Savan, Beth. "Address to the Second Canadian Conference on Gender, Science and Medicine." Toronto, November 2, 1990.

Science Council of Canada. *Who Turns the Wheel?* Minister of Supply and Services, Ottawa, 1981.

Scott, Joan. "Is There a Problem?" in *Who Turns the Wheel?* Proceedings of the Workshop on the Science Education of Women (Ottawa: Science Council of Canada, 1982) pp. 21-44.

Sheinin, Rose and de La Cour, Lykke. "Canadian Women Medical Scientists of 1870-1911: A made-invisible Canadian product." *The Crucible* (1986).

Sheinin, Rose. "The Rearing of Women for Science, Engineering and Technology." *International Journal of Women's Studies* (1981) *4*:339-347.

-------. "Women in science . . . and why not/nought?" in Ferguson, (1982) Who Turns the Wheel? pp. 13-20.

-------. "Women in science and why not/nought? a reassessment?" in Ching (1983) pp. 3-12.

-------. "Women in science: issues and actions." Canadian Women's Studies (1984). 5:70-77.

Solomon, Barbara Bryant. "Demographic changes and women on Campus," American Behavioral Scientist (July-August 1989) 32:640.

"Some Canadians still Trailing Copernicus in Basic Science Knowledge, Survey Finds," Toronto Globe, March 1, 1990, p. A2.

Stark, Elizabeth. "Motherhood and Science do Mix, research on the productivity of women scientists" Psychology Today (June '87) 21:14).

Stark-Adamec, Cannie. "Sexism in Research: The Limits of Academic Freedom" address to the Second Conference on Gender, Science an Medicine, Toronto, November 2, 1990.

Statistics Canada. Canada Yearbook. Ottawa: Minister of Supply and Services. Volumes 1951-1989.

Statistics Canada: Education in Canada: A Statistical Review. Ottawa: Minister of Supply Services 1980-81 to 1988-89.

Statistics Canada Dimensions. Ottawa: Minister of Supply and Services. 1980-81 to 1988-89.

Steed, Judy "Battle of the Sexes." Toronto Star, July 7, 1990. p. D1

Stratham, A., E. M. Miller and H. O. Mauksch, eds. The Worth of Women's Work: A Qualitative Synthesis. Albany: State University of New York Press. 1988.

Strong-Boag, Veronica. The New Day Recalled: Lives of Girls and Women in English Canada, 1919-1939. Toronto: Copp Clark, 1988.

Tannen, Debra. You Just Don't Understand: Men and Women Talking to Each Other. 1990.

"The future now: Canada lags behind in science and technology" Macleans (April 20, '87) 100:34.

Tobias, Sheila. They're Not Dumb, They're Different; Stalking the Second Tier, Tucson Arizona: Research Corporation, 1990.

Troshynski, Dan. "Education and high-tech manufacturing," (Jan.- Feb. 89) 64:43.

Tsuji, Gerry and Suzanne Ziegler. "What Research Says About Increasing the Numbers of Female Students Taking Math and Science in Secondary Schools." Scope 4. (Feb. 1990).

Turner, Judith Axler. Chronicle of Higher Education (Dec. 6 '89) 36:A13.

Tyree, Andrea and Hicks, Rebecca. "Sex and the second moment of prestige distributions," Social Forces (June '88) 66:1028.

University of Toronto, Task Force on Professional Image and Women in Engineering. Report. Toronto: University of Toronto Faculty of Applied Science and Engineering, Sept. 1990.

Vickers, J. "Women in the Universities," in G. Matheson, ed. Women in the Canadian Mosaic. Toronto: Peter Martin, 1976.

Vickers, J. and Adams, J. But Can You Type? Canadian Universities and the Status of Women. Toronto: Clarke Irwin and the Association of Colleges and Universities, 1977.

*Vision 2000: A framework for Reviewing the Mandate of Ontario's System of Colleges of Applied Arts and Technologies. Toronto: Ontario Council of Regents, 1988.

*Vision 2000: Quality and Opportunity. Toronto: Ontario, Ministry of Colleges and Universities, 1990.

Wallace, Geraldine Kenny and Fraser Mustard, "From Paradox to paradigm: the evolution of science and technology in Canada" Deadalus (Fall '88) 117:191.

Walsh, Mary Roth. "Doctors Wanted: No Women Need Apply": Sexual Barriers in the Medical Profession. New Haven: Yale University Press, 1978.

Walter, Caroline Ambler, "The Dilemma of the Female Physician in the Feminist Health Centre". Journal of the American Medical Women's Association (March-April, 1988) pp.45-50

Watts, R. "The Challenge and Opportunities facing Post-Secondary Education in Canada," The Forum Papers. Toronto: National Forum on Post-Secondary Education, The Institute for Research on Public Policy, 1987.

"What Produces Scientific Genius?" USA Today (June '89) 117:11.

White, Jerry, Hospital Strike. Toronto: Thompson, 1990.

Wickens, Barbara. "Seeking the best" Macleans (Nov. 20 '89) 102:68.

Widnall, Sheila. "AAAS Presidential Lecture: Voices from the Pipeline." Science (1988) 241:1740-1745.

Wiggan, L.F., ed. Mathematics: The Invisible Filter. Toronto: Toronto Board of Education, 1982.

Wiggan, L. in Ellis, Dormer, ed. Math 4 Girls: Four Research Based Essays Concerning the Mathematical Education for Girls. Toronto: Ontario Research Council, 1988.

Williams, Paul et al. "Women in Medicine: Practice Patterns and Attitudes." Canadian Medical Association Journal (1990) 143:194-201.

Wilson, E. O., On Human Nature. (Cambridge, Ma: Harvard University Press, 1978).

Wismer, Susan. Women's Education and Training in Canada. Toronto: CCLOW, 1988.

*Women in Canada A Statistical Report. Ottawa: Ministry of Supply and Services, 1990.

Women in Science, Hopefully (W.I.S.H.). Strategies: Intervention Techniques to Retain Women in Mathematics and Science Studies. North York, 1988.

Woolf, Virginia. A Room of One's Own. London: Grafton Books, 1929.

Wolfe, D. "New Technology and Education: A challenge for the Colleges" in Colleges and the Changing Economy, Background Papers. Toronto: Ontario Council of Regents, 1989).

Yalnizyan, Armine. The Impact of Technologic Change on Hospital Workers. Toronto: Service Employees International Union, Local 204, 1986.

* Available in French

EDUCATIONAL RESOURCES

Print:

York University. *STRATEGIES: Intervention Techniques to Retain Women in Mathematics and Science Studies*. 1988 (Office of Admissions/Liaison, York University, 4700 Keele St., North York, Ontario M3J 1P3). **Provides list of University-based programs in Canada.**

Robertson, Heather-Jane. *The IDEA Book: A Resource for Improving the Participation and Success of Female Students in Math, Science and Technology*. Ottawa: Canadian Teachers' Federation, 1988 (110 Argyle Ave., Ottawa, Ontario K2P 1B4). **Lists math, science, computer and technology programs, most school-based, most in Ontario.**

Status of Women Canada. *Participation of Girls and Women in Math, Science and Technology*. Ottawa: Status of Women Canada 1989 (151 Sparks St., Room 1005, Ottawa, Ontario, K1A 1C3).

Ainley Marianne G. (ed.) *Despite the Odds: Essays on Canadian Women and Science*. Montreal: Vehicule Press, 1990. **First book to address the status of Canadian women in the science from an historical and contemporary perspective.**

Canadian Organizations:

Canadian Association for Women in Science (CAWIS), c/o John Fletcher and Associates, 6519b Mississauga Rd., Mississauga, Ontario L5N 1A6. 416: 567-7190

Society for Canadian Women in Science and Technology (SCWIST), P.O. Box 2184, Vancouver, British Columbia, V6B 3V7

Women in Science and Engineering (WISE), Box 6067, Station A, Toronto, Ontario M5W 1P5

Women in Scholarship, Engineering, Science and Technology (WISEST),
c/o Dr. Margaret-Ann Armour, Department of Chemistry, University of Alberta,
Edmonton, Alberta, T6G 2G2

Women Inventors Project, c/o Dr. Shelly Beauchamp, P.O. Box 689, Waterloo, Ontario N2J 4B8 , 519: 746-3443

Ontario Women's Directorate, c/o Ann Holmes, 480 University Ave., 3rd floor, Toronto, Ontario, M5G 1Z2 416: 597-4587